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UNCLASSIFIED TETRAT-TC-3951-02 NL

1 OF 2
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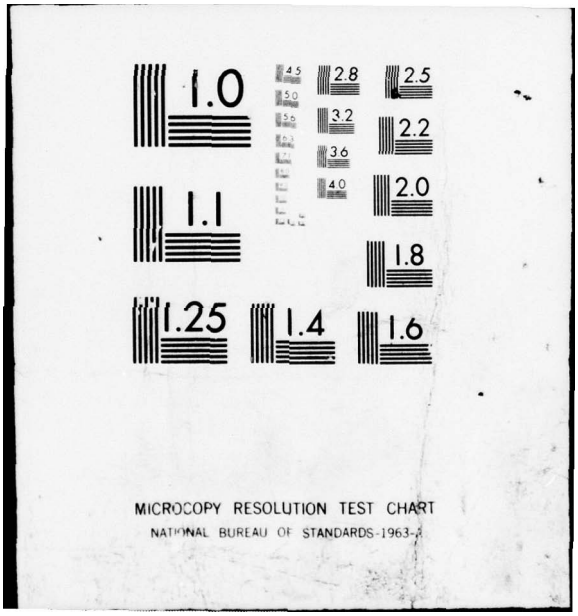
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Report No. TC 3951-02
Contract No. N00014-78-C-0146

LEVEL II

COMPUTER PROGRAM FOR CALCULATING PARTIALLY CAVITATING CASCADE FLOWS IN NONLINEAR THEORY

By
OKITSUGU FURUYA

TETRA TECH, INC.
630 NORTH ROSEMEAD BOULEVARD
PASADENA, CALIFORNIA 91107

JANUARY, 1979

Prepared for
DAVID W. TAYLOR NAVAL SHIP R&D CENTER
BETHESDA, MARYLAND 20084

OFFICE OF NAVAL RESEARCH
800 NORTH QUINCY STREET
ARLINGTON, VIRGINIA 22217

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A nonlinear theory for solving partially cavitating cascade problems was formulated in two different types of input data set-ups, one specifying cavitation number and the other the cavity length. The second method was necessary to find a unique solution because the cavity length has two different values for a specified cavitation number in some blade geometry cases. The report describes the structure of program including various subroutines, input data set-up, typical output data and listing.

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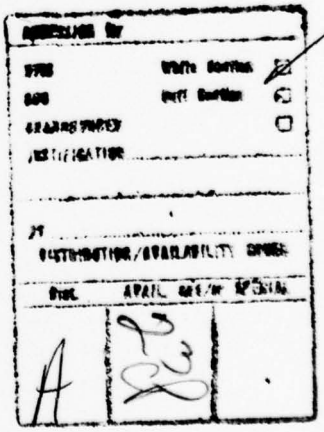


1.0 INTRODUCTION

As has been described in the text [1], two computer programs were developed under the present work, one specifying the cavitation number to determine the cavity length and the other specifying the cavity length to determine the corresponding cavitation number, both in partially cavitating flow conditions. The former is called "PCAS" and the latter is called "PCASL". The explanation in regard to which program is to be used for different cascade flows and geometric configurations is given in [1]. The general rule of thumb is that if the length of cavity is close to the chord length and the upper foil portion has relatively small negative camber, PCAS converges rapidly whereas if the cavity length is short in addition to the existence of the high negative chamber on the suction side of the cascade blade, PCASL must be used for convergence. Five solution parameters are to be determined for PCAS: those are three transform coordinates, scaling factor for mapping, and deflected flow angle at downstream infinity. For PCASL, one extra solution parameter, i.e., length of cavity, makes the total number of solution parameters six. Naturally, it will need more computer time for PCASL than PCAS.

In the following we will describe the structure of program including various subroutines, input data set-up, typical output data and listing for PCAS. For PCASL, there is no difference in terms of input data except for one extra solution parameter so that only listing is provided. It is believed that there will be no difficulty in running PCASL once one becomes familiar with PCAS.

2.0 STRUCTURE OF PCAS

PCAS consists of a main program and several subroutines, brief descriptions of which will be given as follows:

1) MAIN PROGRAM PCAS

- o Specify the dimensions for data.
- o Read input data.
- o Exercise Newton's iterative procedure.
- o Calculate lift and drag coefficients at the end of each iteration.
- o Calculate the cavity profile.

2) SUBROUTINE OXFNEW(X,STOL,M,I,DG,DF,FFF4)

- o Exercise Newton's iterative procedure in calculations for the five integral equations to find the five unknown solution parameters.

x: Input and output data in array SXSI(I)
- SXSI(1): ξ - coordinate for the point B of the foil.
- SXSI(2): ξ - coordinate for the point C.
- SXSI(3): ξ - coordinate for the point F.
- SXSI(4): $\tilde{A}$, coefficient of the mapping function.
- SXSI(5): x_2, downstream flow angle.

STOL: Control variables for the accuracy of Newton's iterations.

M: Number of desired iterations for Newton's procedure.

I: Counts the number of iterations of Newton's procedure. This is defined within OXFNEW.

DG: This is one of the assigned finite differences for the numerical derivations of $\frac{\partial f}{\partial x}$. However, it is no longer used in the calculations themselves as it has been replaced by the array DELI(I,J) which is read in at the beginning of the program.

DF: Same as DG.

FFF4: The residue of equation F(4); if FFF4 becomes larger than S4 of input data, the program is stopped.

3) SUBROUTINE OFSIM1 (ANS,NOF,XCA)

- o Calculates integral I(1) of integral equation F(1) for special ease of foil shape with rounded left end. Called from subroutines: F1INTL, RMINT, CAVITY (see Reference [1] for F(1)).

ANS: Final answer for the integral I(1) of equation F(1).

NOF: This is a controlling variable passed on from the calling subroutines:

NOF = 0 - OFSIM1 called from F1INTL
NOF = 1 - OFSIM1 called from RMINT for real part
NOF = 2 - OFSIM1 called from RMINT for imaginary part
NOF = 3 - OFSIM1 called from CAVITY OXFNEW at F(5)

XCA: Integration variable passed on to OFSIM1 only if NOF = 3.

4) SUBROUTINE OFSIM2 (ANS2)

- o Controls iterative procedure for calculating integral equation F(4). Called from OXFNEW (see Reference [1] for F(4)).

ANS2: Final answer of OFSIM2

5) SUBROUTINE OFSIM3 (Y,XXII,IP,I)

- o Calculates $g_1(\xi)$ in integral equation F(4). Called from OFSIM2. (see [1] for $g_1(\xi)$).

Y: Integration variable passed from OFSIM2, corresponding to ξ.

XXII: Returns value of $g_1(\xi)$ to OFSIM2. The parameter is passed from OFSIM2 to OFSIM3 in the form of one element of an array (XITC(I)) inside an iterative loop.

IP: Number referring to the control point; IP = 1 to LPM.

I: I = 2 for the subdivided middle point between the regular control points specified by IP; I = 3 for the control points.

6) SUBROUTINE OFSIM5(ANS5)

- o Calculates values of F(5) using Simpson's rule and Chebyshev-Gauss polynomials.

ANS5: Value returned to loop in OXFNEW for equation F(5).

7) SUBROUTINE F1INTL (YINT, KCTRL)

- o Calculates integrals in integral equation F(1). Called from OXFNEW.

YINT: Value returned for integral each time F1INTL is called.

KCTRL: Control variable passed from OXFNEW directing which of the four integrals in F(1) is to be calculated. (see [1]).

8) SUBROUTINE G2(XS2,AG2,IS2)

- o Calculates g_2 (ξ) in F(5) given integral variable ξ, i.e., XS2. Called from iterative loop in OFSIM5.

XS2: Abscissa subdivision points from which g_2 (ξ) are calculated, i.e., ξ.

AG2: Value for g_2 (ξ) returned to OFSIM5 after each time it is called.

IS2: Number of control points on the second arc S2.

9) SUBROUTINE RMINT(SR,SM,MIQ)

- o Calculates r_1, r_2, r_3, r_4; m_1, m_2, m_3, m_4 of equations F(2) and F(3) respectively. These values are used to calculate F(2) and F(3) in OXFNEW (see [1]).

SR: Value for r returned to OXFNEW

SM: Value for m returned to OXFNEW

MIQ: Control variable passed from OXFNEW dictating which value (1, 2, 3 or 4) of r or m is to be calculated.

10) SUBROUTINE CAVITY (XCC, YCC)

- o Calculates coordinates of points along cavity cross-section to give cavity shape. Passes cavity endpoint coordinates back to OXFNEW.

XCC: Value returned to OXFNEW for x coordinate of cavity endpoint.

YCC: Value returned to OXFNEW for y coordinate of cavity endpoint.

11) SUBROUTINE IC2(SR,SM,XCA, ISIC)

- o When ISIC = 0 used to calculate r_4 and m_4 of equations F(2) and F(3) respectively. It is then called from OXFNEW. When ISIC = 1 it is used to calculate.

SR,SM: When called from RMINT this is the returned value for r_4 and m_4. When called from CAVITY, only SR is used and SM becomes dummy (see Reference [1]).

XCA: Only used for ISIC = 1, integration variable.

ISIC: This is a control variable which tells IC2 whether to do calculation for OXFNEW or for OFSIM5 or CAVITY.

= 0 called from RMINT.

= 1 called from CAVITY IN OFSIM5 for F(5).

12) SUBROUTINE MOSEC (A,B,ER1,X,J,XLPA,IS1I2)

- o Finds a root of f(x) = 0 where x must lie between A and B and f(A)>0, f(B)<0.

A,B: A root of f(x) = 0 exists between A and B.

ER1,ER2: Accuracy controlling variables where $|x_{real} - x| < ER1$ and $|f(x_{real}) - f(x)| < ER2$.

x: A root of f(x) = 0, found in this subroutine and returned to the calling program.

J: Number of iterations done in MOSEC.

13) FUNCTION AITKEN(XX,YY,X,N)

- o Interpolate the value corresponding to X with the data of XX(N), YY(N) specified by Aitken method.

14) SUBROUTINE DETERM (A,N,D)

- o Calculates determinant of a matrix A of rank N

A: Matrix input, requiring dimension.

N: Rank of the matrix.

D: Calculated determinant of A.

15) SUBROUTINE ARCS2 (S2,XC,YC)

- o Calculates the arc length of the upper wetted portions S2. Called from OXFNEW in calculations for F(5) after the CAVITY subroutine.

S2: returned arc length of arc S2.

XC: X-coordinate of cavity endpoint.

YC: y-coordinate of cavity endpoint.

16) SUBROUTINE ARCLEN (XSS,XL,XH,IS1I2)

- o Calculates arc length of small intervals between XL and XH along foil profile.

XSS: Returned arc segment length.

XL: Lower x coordinate of segment endpoint.

XH: Upper x coordinate of segment endpoint.

IS1I2: Control variable telling the routine whether the upper or lower edge of the foil is to be looked at; IS1I2 = 0 for the lower edge, IS1I2 = 1 for the upper edge.

17) SUBROUTINE XCYC (XCB,YCB,CX,CY)

- o Calculates the point on the upper face of the foil corresponding to the endpoint of the cavity.

XCB: X-coordinate of returned point on foil.

YCB: Y-coordinate of returned point on foil.

CX: X-coordinate of cavity endpoint.

CY: Y-coordinate of cavity endpoint.

18) SUBROUTINE BBBETA (XX,RBETA, IS1I2)

- o Calculates BETA(X(XSI))

XX: X-coordinate of the body for which the local body slope RBETA to be calculated.

RBETA: Local body slope in radians calculated in this subroutine.

IS1I2: Control variable; = 0 for the lower portion

19) SUBROUTINE FARC (FAR, XLPA,X1B,IS1I2)

- o Calculates the difference between the arc length DSS and that corresponding the ξ-coordinates of XLPA and X1B.

IS1I2: The same as that in BBBETA.

20) SUBROUTINE SHAPE (X,Y,BETA,IS1I2)

- o Calculates points along cross-section of foil to give shape of foil. Also gives the angle of the tangent to the foil at each point.

X: X-coordinate for which Y and BETA to be calculated.

Y: Y-coordinate of calculated point.

BETA: Angle of tangent to the foil at calculated point.

IS1I2: Control variable to tell the subroutine whether to look at the upper or lower face of the foil.

3.0 INPUT DATA

The following data are for the program PCAS (Partially Cavitating Cascade Cases). Formatting examples are shown in section 3.2. For running most cases, only a few data cards must be changed such as: cavitation number (SIGMA) and thickness (TH). In trying to obtain a convergent solution, updated data for the five parameters, SXSI(I), can be stored on tape and recalled by changing IREAD = 1 and IFLAG = 0. In this way new data need not be punched in and consecutive runs may be made very quickly.

It is important to note that the program, as it stands, is for plano-convex foils only. The thickness of the foil can be changed simply by changing TH. TH = 0 is the case of a flat plate. However, the input data set-up includes the capability of calculating the partially cavitating propeller local flows. The input parameters relating the propeller blade configurations include R, AAAA, to CCCC, A8 to D8, XROUD and AZAA to CZCC. In order to calculate the plano-convex blade cascade flow, these parameters are disregarded although dummy cards should be provided.

Different profiles may be analyzed through suitable changes in the program. Subroutines which must be changed are: ARCS2, ARCLEN, XCYC, and SHAPE. Coefficients for equations describing the profiles must be read in at the beginning of the program. Other data which can be changed are R, radial location on propeller blade; XROUND, the leading edge radius in the case of a rounded end; SBETA, the angle of incidence; SBETA2, the body angle of flat plate; ISHARP, specifies sharp or rounded leading edge; ALFAlS, flow angle; GAMMAS, cascade stagger angle; SOLIS, solidity of the cascade.

3.1 INPUT DATA FOR PCAS (PARTIALLY CAVITATING CASCADE CASES)

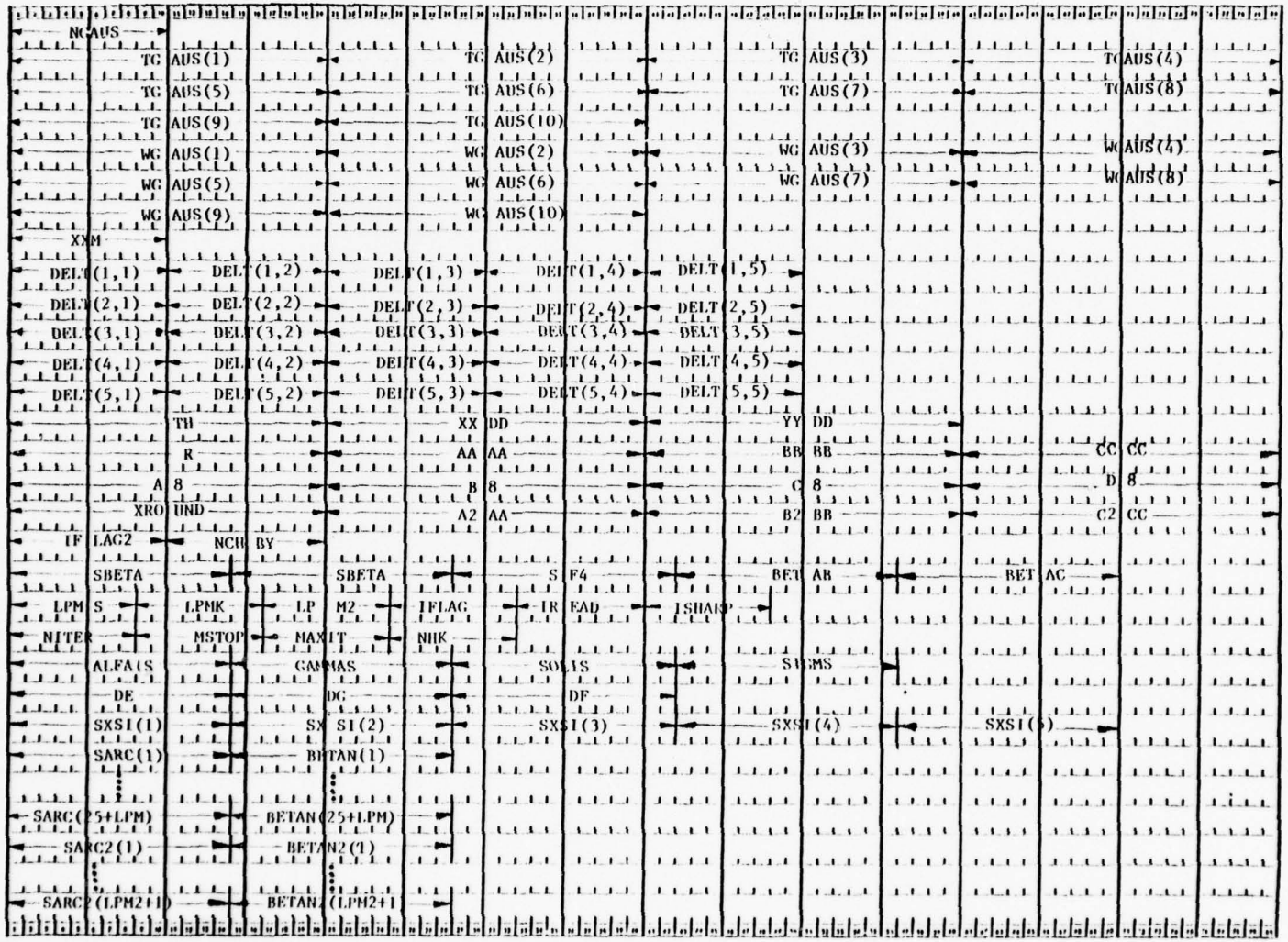
DATA CARD NO.	SYMBOL	DESCRIPTION
1	NGAUS	Number of subdivisions used in Gaussian integration.
2-4	TGAUS(I)	Abscissas of Gaussian integration.
5-7	WGAUS(I)	Weight factors of Gaussian integration.
8	XXM	Weighting factor for solution parameters in iterative procedure (0 to 1).
9-13	DELT(X,Y)	Increment for numerical calculations of partial derivatives.
14	TH	The thickness in percent of the plano-convex foil.
15	R	Specifies the radial location on the propeller blade. (normalized to be unity at the tip)
	AAAA,BBBB,CCCC	Coefficients for terms in the equation of the cross-sectional shape of the lower face of the propeller blade. These coefficients are used in the second equation for x values along the cross-section where $.2 \leq x \leq .8$ (see Reference 2 for the form of equation)
16	A8,B8,C8,D8	Coefficients for third equation of cross-sectional shape where $x \leq .8$ (see [2] for the form of equation)
17	XROUND	Leading edge radius. This is actually used only when ISHARP = 1 (rounded leading edge). Otherwise it is a dummy variable.
	A2AA,B2BB,C2CC	Coefficients for first equation of cross-sectional shape where $x \leq .2$ (see [2] for the form of equation)

18	IFLAG1	= 0 - for regular runs ≠ 0 - for runs reading data from CASCLIM. Needs extra data for SXSI(2), SXSI(3).
	NCHBY	The number of Chebyshev-Gauss control points.
19	SBETA	Initial angle of incidence for a starting flat plate solution in degrees.
	SBETA2	Body angle of a flat plate in degrees. Used as an initial solution.
	SF4	Always set = 10. Used to stop computation if the calculated arc length S1 becomes larger than SF4.
	BETAB	Body angle at point B.
	BETAC	Body angle at point C. (initially assumed value)
20	LPMS	Number of control points over the ξ coordinates between ξ = -1 and b. Used for first arc length S1. (see Reference [1])
	LPKS	Number of subdivisions between ξ = b and the last point of the coarse division made by LPMS.
	LPM2	Same as LPMS only used for calculations on second arc length S2. Note that there is only 1 segment spacing here.
	IFLAG	= 1 - for first run which requires data to be fed in, i.e., but only SXSI(1) to SXSI(5). = 0 - for use of previous data in which case data will be read either from a data card (if IREAD = 5) or from tape (if IREAD = 1). For IREAD = 5, not only SXSI(1) to SXSI(5) but also SARC(I), BETAN(I); SARC2(I), BETA2(I) must be read from the data card.

	IREAD	Used for controlling where data is read from. Either tape or card as above.
	ISHARP	= 0 - for sharp leading edge. = 1 - for rounded leading edge.
21	NITER	Number of flow configurations to be calculated in 1 run.
	MSTOP	Number of iterations to stop the larger nest.
	MAXIT	Number of iterations for Newton's loop.
	NHK	Control index for varying either the set values of the angle of incidence, solidity, or cavitation number, depending on 1, 2, or 3, respectively for the NITER loop.
22	ALFA1S	Flow incidence angle in degrees. (see Figure 1)
	GAMMAS	Cascade geometric stagger angle in degrees. (see Figure 1)
	SOLIS	Solidity of the cascade ($= {}^{c}/_{s}$ in Figure 1)
	SIGMS	Cavitation number $= (p_1 - p_c)/\frac{1}{2}\rho V_1^2$
23	DE,DG,DF	Finite differences for numerical derivations of $\frac{\partial f}{\partial x}$ in subroutine OXFNEW. These are replaced by DELT(I,J), no longer used.
24	SXSI(I), I = 1,5	This card is necessary only if IFLAG = 1; SXSI(I), I = 1,5 correspond to b, c, a, Ã and x_2. Values for SXSI(I) must be arbitrarily assumed and tried to see if a convergent solution is obtained.

25 ~ (25 + LPM)	SARC(1), BETAN(1)	Arc length vs. local incidence angle in radians for the lower portion of the body; these data are needed only if IFLAG = 0 and IREAD = 5.
	SARC(LPM), (LPM)	
25 + LPM + 1~	SARC2(1) BETAN2(1)	Arc length vs. local incidence angle in radians for the upper portion of the body; these data are needed only if IFLAG = 0 and IREAD = 5.
	SARC (LPM2 + 1), BETAN2 (LPM2 + 1)	

80 COLUMN PUNCHED CARD LAYOUT



3.3 TYPICAL DATA SET-UP

```
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         .0765265211          .2277858511          .3737060887          .5108670020
         .6360536807          .7463319065          .8391169718          .9122344283
         .9639719273          .9931285992
         .1527533871          .1491729865          .1420961093          .1316886384
         .1181945320          .1019301198          .0832767415          .0626720483
         .0406014298          .0176140071
      0.7
   .0000001  .0000001  .0000001  .0000001  .0000001
   .0000001  .0000001  .0000001  .0000001  .0000001
   .0000001  .0000001  .0000001  .0000001  .0000001
   .0000001  .0000001  .0000001  .0000001  .0000001
   .0000001  .0000001  .0000001  .0000001  .0000001
      .00
0.5                0.01193            -0.0602553          -0.0041395
0.1034867          -0.4542559          0.5308437          -0.2476181
0.0000965          -0.0653112          0.1579089          -0.3673004
         0        40
            0.          -130.          10.          -130.          -180.
      71      30      40      1       5       0
       1       1       3      1
            8.          37.          .625          1.2
         1.E-7          1.E-5          1.E-5
      .0020874       .0555454       .1552182       .0433760       .0184135
```

4.0 OUTPUT DATA

Typical output data are also listed at the end of the program listing. Most of them are self-explanatory, however, those not explained in output data are described as follows:

- T(I): This is just a repetition of the input data TGAUS(I).
- W(I): Repetition of input data WGAUS(I).
- X(I): Solution parameters corresponding to SXSI(I). Each time these appear they are an updated version of those preceding them.
- CAV(X): This gives the x-coordinate of the cavity endpoint.
- CAV(Y): This gives the y-coordinate of the cavity endpoint.
- P(I,J): Partial derivatives of Function F(I) used for Newton's method.
- YINT4: Solution to 4th integral of equation F(1).
- SOLNR & SOLNM: Intermediate calculated values of integrals, only used for checking the numerical accuracy.
- F(X): Residue of each function F(1)...F(5)
- CLINF: Lift coefficient at infinity.
- CDINF: Drag coefficient at infinity.
- CCDD: Drag coefficient.
- CCLL: Lift coefficient.
- $L/_D$: Cavity length to chord ratio.
- BIGS2: Arc length of the face of the foil. Either upper or lower face.
- XCCC: x-coordinate of cavity endpoint.
- YCCC: y-coordinate of cavity endpoint.

XS2D: Intermediate values used as a check for progress of program. Can be ignored.

XKSI: Intermediate values used as a check for progress of program. Can be ignored.

BBTAN2: Slope of foil profile at Chebychev-Gauss subdivision points.

4.1 TYPICAL OUTPUT DATA

```
T(I)= .07650652  .22776566  .37370609  .51086700  .63605368  .74633191  .83911697  .91223443  .96397193
.(I)= .10276359  .14917299  .14209611  .13168864  .11819453  .10183012  .08327674  .06267205  .04060143
        DELTA(1,J)= .00000010   .00000010   .00000010   .00000010   .00000010
        DELTA(2,J)= .00000010   .00000010   .00000010   .00000010   .00000010
        DELTA(3,J)= .00000010   .00000010   .00000010   .00000010   .00000010
        DELTA(4,J)= .00000010   .00000010   .00000010   .00000010   .00000010
        DELTA(5,J)= .00000010   .00000010   .00000010   .00000010   .00000010
                    THICKNESS OF FLAP CONVEX FOIL =    0.00000          XXM=    .70000
                    BETAE AND BETAC AS FIRST GUESS=-180.00000  -180.00000
                    K=  .50  AAAA=   .011930  BBBB=  -.002258  CCCC=  -.004140
                    A8=   .103487  B8=  -.454256  C8=   .530844  D8=  -.247618
                    XROUND=   .000097  A2AA=  -.065611  B2BB=   .157909  C2CC=  -.367300
    LPM=  71  LPX=  30  SBETA= 0.                    IREAD=1  NCHEK= 40
        DE=  .1000000E-05  DG=  .1000000E-02DF=  .1000000E-04  SF4=  .1000000E+02
        SBETA2= -.1800000E+03
        LPM2= 60  ISHARP= 0.
INCIDENCE ANGLE=  .9000000E+01 GAMMA=  .3600000E+02 SOLIDITY=  .8250000E+00
    FLAP ANGLE= 0.
        CAVIT. NO =  .3750000E+00
        CHORD=  .1000000E+01  UPPER SEP. POINT= 0.              CONN. POINT(XC,YC)=( 0.          , 0.
        BIGS=  .1000000E+01
        ITERATION NO.= 2
X(1)=  .8933550E-03
X(2)=  .1673660E+00
X(3)=  .1724534E+00
X(4)=  .4634349E-01
X(5)= -.1558505E-01
                I=  1  BETAN2= -.3141593E+01  XKSI=  .1679877E+00
                I=  2  BETAN2= -.3141593E+01  XKSI=  .1690014E+00
                I=  3  BETAN2= -.3141593E+01  XKSI=  .1686267E+00
                I=  4  BETAN2= -.3141593E+01  XKSI=  .1680695E+00
                I=  5  BETAN2= -.3141593E+01  XKSI=  .1681734E+00
                I=  6  BETAN2= -.3141593E+01  XKSI=  .1681903E+00
                I=  7  BETAN2= -.3141593E+01  XKSI=  .1682595E+00
                I=  8  BETAN2= -.3141593E+01  XKSI=  .1683606E+00
                I=  9  BETAN2= -.3141593E+01  XKSI=  .1684634E+00
                I= 10  BETAN2= -.3141593E+01  XKSI=  .1685708E+00
                I= 11  BETAN2= -.3141593E+01  XKSI=  .1687003E+00
                I= 12  BETAN2= -.3141593E+01  XKSI=  .1688330E+00
                I= 13  BETAN2= -.3141593E+01  XKSI=  .1689743E+00
                I= 14  BETAN2= -.3141593E+01  XKSI=  .1691232E+00
                I= 15  BETAN2= -.3141593E+01  XKSI=  .1692787E+00
                I= 16  BETAN2= -.3141593E+01  XKSI=  .1694400E+00
                I= 17  BETAN2= -.3141593E+01  XKSI=  .1696041E+00
                I= 18  BETAN2= -.3141593E+01  XKSI=  .1697759E+00
                I= 19  BETAN2= -.3141593E+01  XKSI=  .1699495E+00
                I= 20  BETAN2= -.3141593E+01  XKSI=  .1701264E+00
                I= 21  BETAN2= -.3141593E+01  XKSI=  .1703070E+00
                I= 22  BETAN2= -.3141593E+01  XKSI=  .1704711E+00
                I= 23  BETAN2= -.3141593E+01  XKSI=  .1706435E+00
                I= 24  BETAN2= -.3141593E+01  XKSI=  .1708133E+00
                I= 25  BETAN2= -.3141593E+01  XKSI=  .1709794E+00
                I= 26  BETAN2= -.3141593E+01  XKSI=  .1711407E+00
                I= 27  BETAN2= -.3141593E+01  XKSI=  .1712962E+00
                I= 28  BETAN2= -.3141593E+01  XKSI=  .1714451E+00
                I= 29  BETAN2= -.3141593E+01  XKSI=  .1715864E+00
                I= 30  BETAN2= -.3141593E+01  XKSI=  .1717191E+00
                I= 31  BETAN2= -.3141593E+01  XKSI=  .1718426E+00
                I= 32  BETAN2= -.3141593E+01  XKSI=  .1719560E+00
                I= 33  BETAN2= -.3141593E+01  XKSI=  .1720586E+00
                I= 34  BETAN2= -.3141593E+01  XKSI=  .1721499E+00
                I= 35  BETAN2= -.3141593E+01  XKSI=  .1722291E+00
                I= 36  BETAN2= -.3141593E+01  XKSI=  .1722960E+00
                I= 37  BETAN2= -.3141593E+01  XKSI=  .1723499E+00
                I= 38  BETAN2= -.3141593E+01  XKSI=  .1723907E+00
                I= 39  BETAN2= -.3141593E+01  XKSI=  .1724180E+00
```

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                I= 40  BETAN2= -.3141593E+01  XKSI=  .1724317E+00
YINT4=          -.0000000054
SOLNM=          -.0000000370  SOLNM=          -.0000000067
XS20=           .0000007772
XS20=           .0000007769
XS20=           .0000007766
XS20=           .0000007763
XS20=           .0000007760
XS20=           .0000007757
XS20=           .0000007754
XS20=           .0000007751
XS20=           .0000007747
XS20=           .0000007745
XS20=           .0000007742
XS20=           .0000007739
XS20=           .0000007736
XS20=           .0000007733
XS20=           .0000007730
XS20=           .0000007727
XS20=           .0000007724
XS20=           .0000007721
XS20=           .0000007718
XS20=           .0000007715
XS20=           .0000007712
XS20=           .0000007709
XS20=           .0000007706
XS20=           .0000007703
XS20=           .0000007700
XS20=           .0000007697
XS20=           .0000007694
XS20=           .0000007691
XS20=           .0000007688
XS20=           .0000007685
XS20=           .0000007682
XS20=           .0000007679
XS20=           .0000007676
XS20=           .0000007673
XS20=           .0000007670
XS20=           .0000007667
XS20=           .0000007664
XS20=           .0000007661
XS20=           .0000007658
XS20=           .0000007655
XS20=           .0000007652
XS20=           .0000007649
XS20=           .0000007646
XS20=           .0000007643
XS20=           .0000007640
XS20=           .0000007637
XS20=           .0000007634
XS20=           .0000007631
XS20=           .0000007628
XS20=           .0000007625
XS20=           .0000007622
XS20=           .0000007619
XS20=           .0000007566
P(I,J)=  .3326894E+02  -.5400188E+01   .3190587E+00   0.            -.4984075E+00
P(I,J)=  .1491456E+02  .6782455E+00   -.3908792E+00   -.3965072E+01   .2466617E+00
P(I,J)= -.5961437E+02  .8240505E+00   -.2986936E+00   .3473282E+00   .1272373E+00
P(I,J)= -.7456661E+02  .4666491E+00   -.2722129E+00   .1357618E+01   .7018934E+00
P(I,J)=  .8168221E+01  .5594640E+01   -.5404651E+01   .1233231E+00   .1461859E-01
                P1BS2=    .33140   XCCC=     .36960   YL[illegible]=     .00797
CA,X=     0.000000     CA,Y=     0.000000
CA,X=     .001067      CA,Y=     .000160
CA,X=     .004268      CA,Y=     .000640
CA,X=     .009603      CA,Y=     .001440
CA,X=     .017072      CA,Y=     .002562
CAVX=     .026674      CAVY=     .004004
CAVX=     .038410      CAVY=     .005766
CAVX=     .052279      CAVY=     .007849
CAVX=     .068283      CAVY=     .010253
CAVX=     .086420      CAVY=     .012979
CAVX=     .106691      CAVY=     .016026
CAVX=     .129096      CAVY=     .019394
CAVX=     .153634      CAVY=     .023084
CAVX=     .180307      CAVY=     .027095
CAVX=     .209113      CAVY=     .031428
CAVX=     .240053      CAVY=     .036082
CAVX=     .273127      CAVY=     .041057
CAVX=     .308335      CAVY=     .046353
CAVX=     .345677      CAVY=     .051971
CAVX=     .385153      CAVY=     .057910
CAVX=     .426763      CAVY=     .064170
CAVX=     .470507      CAVY=     .070752
CAVX=     .516385      CAVY=     .077655
CAVX=     .564397      CAVY=     .084880
```

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          CAVX=     .55965      CAVY=     .10471
          CAVX=     .59161      CAVY=     .10615
          CAVX=     .62152      CAVY=     .10712
          CAVX=     .64956      CAVY=     .10767
          CAVX=     .67579      CAVY=     .10786
          CAVX=     .70046      CAVY=     .10773
          CAVX=     .72372      CAVY=     .10732
          CAVX=     .74565      CAVY=     .10666
          CAVX=     .76637      CAVY=     .10577
          CAVX=     .78599      CAVY=     .10467
          CAVX=     .80460      CAVY=     .10337
          CAVX=     .82226      CAVY=     .10188
          CAVX=     .83911      CAVY=     .10021
          CAVX=     .85514      CAVY=     .09836
          CAVX=     .87043      CAVY=     .09632
          CAVX=     .88504      CAVY=     .09409
          CAVX=     .89900      CAVY=     .09165
          CAVX=     .91234      CAVY=     .08896
          CAVX=     .92508      CAVY=     .08599
          CAVX=     .93723      CAVY=     .08264
          CAVX=     .94878      CAVY=     .07874
          CAVX=     .95975      CAVY=     .07386
          CAVX=     .96862      CAVY=     .06797
F(1)=  .9533564E-05
F(2)= -.1823830E-04
F(3)= -.1072791E-04
F(4)=  .2270622E-06
F(5)=  .2391792E-02
X(1)=  .8933617E-03
X(2)=  .1673433E+00
X(3)=  .1713299E+00
X(4)=  .4634485E-01
X(5)= -.1 5 0 7 E-01
                    ITERATION NO.= 1
X(1)=  .8933617E-03
X(2)=  .1673433E+00
X(3)=  .1713299E+00
X(4)=  .4634485E-01
X(5)= -.1682333E-01
                I=  1  BETAN2= -.3141593E+01   XKSI=  .1673448E+00
                I=  2  BETAN2= -.3141593E+01   XKSI=  .1673571E+00
                I=  3  BETAN2= -.3141593E+01   XKSI=  .1673816E+00
                I=  4  BETAN2= -.3141593E+01   XKSI=  .1674181E+00
                I=  5  BETAN2= -.3141593E+01   XKSI=  .1674665E+00
                I=  6  BETAN2= -.3141593E+01   XKSI=  .1675264E+00
                I=  7  BETAN2= -.3141593E+01   XKSI=  .1675974E+00
                I=  8  BETAN2= -.3141593E+01   XKSI=  .1676792E+00
                I=  9  BETAN2= -.3141593E+01   XKSI=  .1677712E+00
                I= 10  BETAN2= -.3141593E+01   XKSI=  .1678725E+00
                I= 11  BETAN2= -.3141593E+01   XKSI=  .1679835E+00
                I= 12  BETAN2= -.3141593E+01   XKSI=  .1681025E+00
                I= 13  BETAN2= -.3141593E+01   XKSI=  .1682292E+00
                I= 14  BETAN2= -.3141593E+01   XKSI=  .1683626E+00
                I= 15  BETAN2= -.3141593E+01   XKSI=  .1685021E+00
                I= 16  BETAN2= -.3141593E+01   XKSI=  .1686467E+00
                I= 17  BETAN2= -.3141593E+01   XKSI=  .1687955E+00
                I= 18  BETAN2= -.3141593E+01   XKSI=  .1689477E+00
                I= 19  BETAN2= -.3141593E+01   XKSI=  .1691023E+00
                I= 20  BETAN2= -.3141593E+01   XKSI=  .1692583E+00
                I= 21  BETAN2= -.3141593E+01   XKSI=  .1694149E+00
                I= 22  BETAN2= -.3141593E+01   XKSI=  .1695709E+00
                I= 23  BETAN2= -.3141593E+01   XKSI=  .1697255E+00
                I= 24  BETAN2= -.3141593E+01   XKSI=  .1698777E+00
                I= 25  BETAN2= -.3141593E+01   XKSI=  .1700265E+00
                I= 26  BETAN2= -.3141593E+01   XKSI=  .1701711E+00
                I= 27  BETAN2= -.3141593E+01   XKSI=  .1703106E+00
```

```
                I= 28  BETAN2= -.3141593E+01   XKSI=   .1704440E+00
                I= 29  BETAN2= -.3141593E+01   XKSI=   .1705707E+00
                I= 30  BETAN2= -.3141593E+01   XKSI=   .1706897E+00
                I= 31  BETAN2= -.3141593E+01   XKSI=   .1708004E+00
                I= 32  BETAN2= -.3141593E+01   XKSI=   .1709020E+00
                I= 33  BETAN2= -.3141593E+01   XKSI=   .1709940E+00
                I= 34  BETAN2= -.3141593E+01   XKSI=   .1710756E+00
                I= 35  BETAN2= -.3141593E+01   XKSI=   .1711468E+00
                I= 36  BETAN2= -.3141593E+01   XKSI=   .1712067E+00
                I= 37  BETAN2= -.3141593E+01   XKSI=   .1712551E+00
                I= 38  BETAN2= -.3141593E+01   XKSI=   .1712916E+00
                I= 39  BETAN2= -.3141593E+01   XKSI=   .1713161E+00
                I= 40  BETAN2= -.3141593E+01   XKSI=   .1713284E+00
YINT=          -.0000000049
SOLN=          -.0000000155  SOLN=          -.0000000080
XSID=           .0000007756
XSID=           .0000007752
XSID=           .0000007749
XSID=           .0000007747
XSID=           .0000007744
XSID=           .0000007741
XSID=           .0000007776
XSID=           .0000007773
XSID=           .0000007770
XSID=           .0000007765
XSID=           .0000007763
XSID=           .0000007760
XSID=           .0000007757
XSID=           .0000007754
XSID=           .0000007752
XSID=           .0000007749
XSID=           .0000007746
XSID=           .0000007744
XSID=           .0000007741
XSID=           .0000007737
XSID=           .0000007734
XSID=           .0000007733
XSID=           .0000007727
XSID=           .0000007725
XSID=           .0000007722
XSID=           .0000007720
XSID=           .0000007716
XSID=           .0000007713
XSID=           .0000007711
XSID=           .0000007707
XSID=           .0000007705
XSID=           .0000007703
XSID=           .0000007700
XSID=           .0000007676
XSID=           .0000007671
XSID=           .0000007667
  P(I,J)=  .3330756E+02   -.5525706E+00    .3310912E+00    0.              -.8278648E+00
  P(I,J)=  .1490917E+03    .6957359E+00   -.4076245E+00   -.3904930E+01    .2459498E+00
  P(I,J)= -.5968130E+02    .5373941E+00   -.3105371E+00    .3470362E+00    .1270932E+00
  P(I,J)= -.7883814E+02    .4780747E+00   -.2831855E+00    .9135496E+01    .7016636E+00
  P(I,J)=  .7881970E+01    .5735937E+01   -.5590977E+01   -.1118936E+00    .1327015E-01
                  BIGS=     .03292  YCCC=     .96709  YCCC=     .06861
        CAVX=    0.00000     CAVY=    0.00000
        CAVX=     .00102     CAVY=     .00161
        CAVX=     .00513     CAVY=     .00493
        CAVX=     .01334     CAVY=     .00360
        CAVX=     .02647     CAVY=     .01551
        CAVX=     .04531     CAVY=     .02259
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```
          CAVX=     .07037      CAVY=     .03065
          CAVX=     .10166      CAVY=     .03742
          CAVX=     .13871      CAVY=     .04355
          CAVX=     .18034      CAVY=     .05762
          CAVX=     .22585      CAVY=     .06626
          CAVX=     .27126      CAVY=     .07418
          CAVX=     .31757      CAVY=     .08120
          CAVX=     .36285      CAVY=     .08725
          CAVX=     .40635      CAVY=     .09234
          CAVX=     .44767      CAVY=     .09663
          CAVX=     .48651      CAVY=     .09990
          CAVX=     .52314      CAVY=     .10256
          CAVX=     .55734      CAVY=     .10458
          CAVX=     .58933      CAVY=     .10605
          CAVX=     .61927      CAVY=     .10704
          CAVX=     .64731      CAVY=     .10762
          CAVX=     .67362      CAVY=     .10784
          CAVX=     .69834      CAVY=     .10774
          CAVX=     .72166      CAVY=     .10735
          CAVX=     .74358      CAVY=     .10671
          CAVX=     .76433      CAVY=     .10585
          CAVX=     .78399      CAVY=     .10477
          CAVX=     .80263      CAVY=     .10349
          CAVX=     .82034      CAVY=     .10202
          CAVX=     .83719      CAVY=     .10039
          CAVX=     .85328      CAVY=     .09855
          CAVX=     .86857      CAVY=     .09654
          CAVX=     .88321      CAVY=     .09433
          CAVX=     .89719      CAVY=     .09192
          CAVX=     .91054      CAVY=     .08936
          CAVX=     .92333      CAVY=     .08633
          CAVX=     .93551      CAVY=     .08302
          CAVX=     .94709      CAVY=     .07919
          CAVX=     .95776      CAVY=     .07441
          CAVX=     .96708      CAVY=     .06961
F(1)=  .2552388E-05
F(2)= -.3558289E-05
F(3)= -.2871526E-05
F(4)= -.6844000E-05
F(5)= -.1556789E-02
X(1)=  .8933603E-03
X(2)=  .1677211E+00
X(3)=  .1719972E+00
X(4)=  .4634410E-01
X(5)= -.1557080E-01
                    IFAIL= 0
X(1)=  .8933603E-03
X(2)=  .1677211E+00
X(3)=  .1719972E+00
X(4)=  .4634410E-01
X(5)= -.1557080E-01
          I=  1  BETAN2= -.3141593E+01   XKSI=  .1677228E+00
          I=  2  BETAN2= -.3141593E+01   XKSI=  .1677359E+00
          I=  3  BETAN2= -.3141593E+01   XKSI=  .1677622E+00
          I=  4  BETAN2= -.3141593E+01   XKSI=  .1678014E+00
          I=  5  BETAN2= -.3141593E+01   XKSI=  .1678533E+00
          I=  6  BETAN2= -.3141593E+01   XKSI=  .1679175E+00
          I=  7  BETAN2= -.3141593E+01   XKSI=  .1679937E+00
          I=  8  BETAN2= -.3141593E+01   XKSI=  .1680814E+00
          I=  9  BETAN2= -.3141593E+01   XKSI=  .1681801E+00
          I= 10  BETAN2= -.3141593E+01   XKSI=  .1682892E+00
          I= 11  BETAN2= -.3141593E+01   XKSI=  .1684079E+00
          I= 12  BETAN2= -.3141593E+01   XKSI=  .1685355E+00
          I= 13  BETAN2= -.3141593E+01   XKSI=  .1686713E+00
          I= 14  BETAN2= -.3141593E+01   XKSI=  .1688145E+00
```

```
I= 15  BBTAN2= -.3141593E+01   XKSI=  .1691192E+00
I= 16  BBTAN2= -.3141593E+01   XKSI=  .1692788E+00
I= 17  BBTAN2= -.3141593E+01   XKSI=  .1694421E+00
I= 18  BBTAN2= -.3141593E+01   XKSI=  .1696079E+00
I= 19  BBTAN2= -.3141593E+01   XKSI=  .1697752E+00
I= 20  BBTAN2= -.3141593E+01   XKSI=  .1699431E+00
I= 21  BBTAN2= -.3141593E+01   XKSI=  .1701105E+00
I= 22  BBTAN2= -.3141593E+01   XKSI=  .1702763E+00
I= 23  BBTAN2= -.3141593E+01   XKSI=  .1704395E+00
I= 24  BBTAN2= -.3141593E+01   XKSI=  .1705992E+00
I= 25  BBTAN2= -.3141593E+01   XKSI=  .1707543E+00
I= 26  BBTAN2= -.3141593E+01   XKSI=  .1709039E+00
I= 27  BBTAN2= -.3141593E+01   XKSI=  .1710470E+00
I= 28  BBTAN2= -.3141593E+01   XKSI=  .1711828E+00
I= 29  BBTAN2= -.3141593E+01   XKSI=  .1713105E+00
I= 30  BBTAN2= -.3141593E+01   XKSI=  .1714292E+00
I= 31  BBTAN2= -.3141593E+01   XKSI=  .1715382E+00
I= 32  BBTAN2= -.3141593E+01   XKSI=  .1716369E+00
I= 33  BBTAN2= -.3141593E+01   XKSI=  .1717246E+00
I= 34  BBTAN2= -.3141593E+01   XKSI=  .1718009E+00
I= 35  BBTAN2= -.3141593E+01   XKSI=  .1718651E+00
I= 36  BBTAN2= -.3141593E+01   XKSI=  .1719170E+00
I= 37  BBTAN2= -.3141593E+01   XKSI=  .1719562E+00
I= 38  BBTAN2= -.3141593E+01   XKSI=  .1719824E+00
I= 39  BBTAN2= -.3141593E+01   XKSI=  .1719956E+00
I= 40  BBTAN2= -.3141593E+01   XKSI=  .1719956E+00

YINT=      -.0000000088
SCLNM=     -.0000000057  SCLNM=      -.0000000085
XS2D=      .0000007782
XS2D=      .0000007778
XS2D=      .0000007775
XS2D=      .0000007772
XS2D=      .0000007769
XS2D=      .0000007766
XS2D=      .0000007763
XS2D=      .0000007761
XS2D=      .0000007758
XS2D=      .0000007755
XS2D=      .0000007752
XS2D=      .0000007749
XS2D=      .0000007746
XS2D=      .0000007743
XS2D=      .0000007740
XS2D=      .0000007737
XS2D=      .0000007735
XS2D=      .0000007732
XS2D=      .0000007729
XS2D=      .0000007726
XS2D=      .0000007723
XS2D=      .0000007721
XS2D=      .0000007718
XS2D=      .0000007715
XS2D=      .0000007712
XS2D=      .0000007709
XS2D=      .0000007706
XS2D=      .0000007703
XS2D=      .0000007700
XS2D=      .0000007697
XS2D=      .0000007694
XS2D=      .0000007691
XS2D=      .0000007687
XS2D=      .0000007683
XS2D=      .0000007679
XS2D=      .0000007673
XS2D=      .0000007666
XS2D=      .0000007650
```

```
XS2D=          .000009758
  P(I,J)=   .5426230E+02   -.5445413E+00    .3233681E+00    0.                -.8080176E+00
  P(I,J)=   .1[illegible]1255E+03    .6847454E+00   -.3969422E+00   -.3905092E+01    .2460039E+00
  P(I,J)= -.5[illegible]2770E+02    .5063554E+00   -.3014577E+00    .3470613E+00    .1272004E+00
  P(I,J)= -.7[illegible]1356E+00    .4702073E+00   -.2761684E+00    .9135696E+01    .7016871E+00
  P(I,J)=   .6[illegible]5156E+01    .5645936E+01   -.5482672E+01   -.1191422E+00    .1412314E-01
                    BIGS2=     .03204   XCCC=     .96795   YCCC=     .06820
          CAVX=    0.00000      CAVY=    0.00000
          CAVX=     .00103      CAVY=     .00161
          CAVX=     .00518      CAVY=     .00495
          CAVX=     .01341      CAVY=     .00763
          CAVX=     .02682      CAVY=     .01557
          CAVX=     .04557      CAVY=     .02268
          CAVX=     .07076      CAVY=     .03077
          CAVX=     .10223      CAVY=     .03957
          CAVX=     .13943      CAVY=     .04871
          CAVX=     .18123      CAVY=     .05780
          CAVX=     .22611      CAVY=     .06645
          CAVX=     .27245      CAVY=     .07436
          CAVX=     .31[illegible]3      CAVY=     .08138
          CAVX=     .36417      CAVY=     .08741
          CAVX=     .40771      CAVY=     .09249
          CAVX=     .44905      CAVY=     .09666
          CAVX=     .48799      CAVY=     .10001
          CAVX=     .52452      CAVY=     .10269
          CAVX=     .55875      CAVY=     .10466
          CAVX=     .59068      CAVY=     .10610
          CAVX=     .62055      CAVY=     .10706
          CAVX=     .64861      CAVY=     .10764
          CAVX=     .67490      CAVY=     .10794
          CAVX=     .69960      CAVY=     .10773
          CAVX=     .72286      CAVY=     .10733
          CAVX=     .744[illegible]      CAVY=     .10667
          CAVX=     .76[illegible]57      CAVY=     .10579
          CAVX=     .7851[illegible]      CAVY=     .10476
          CAVX=     .80379      CAVY=     .10341
          CAVX=     .82[illegible]      CAVY=     .10193
          CAVX=     .84[illegible]      CAVY=     .10026
          CAVX=     .85[illegible]      CAVY=     .09842
          CAVX=     .87[illegible]      CAVY=     .09639
          CAVX=     .88[illegible]      CAVY=     .09417
          CAVX=     .89[illegible]      CAVY=     .09174
          CAVX=     .9116[illegible]      CAVY=     .08907
          CAVX=     .92[illegible]      CAVY=     .08610
          CAVX=     .93[illegible]      CAVY=     .08277
          CAVX=     .94[illegible]      CAVY=     .07890
          CAVX=     .95[illegible]      CAVY=     .07407
          CAVX=     .96[illegible]      CAVY=     .06820
P(1)=  .1[illegible]E-05
P(2)= -.1[illegible]E-05
P(3)= -.1[illegible]E-05
P(4)=  .1[illegible]E-05
P(5)=  .[illegible]E-03
X(1)=  .[illegible]E-03
X(2)=  .1[illegible]E+00
X(3)=  .171[illegible]E+00
X(4)=  .463[illegible]E-01
X(5)= -.1857721E-01
                    ITERATION NO.= 3
[illegible]XPNE. [illegible] NOT CONVERGE WITHIN [illegible]
          SXSI(1)=  .8933622E-03
          SXSI(2)=  .1674993E+00
          SXSI(3)=  .1716[illegible]E+00
          SXSI(4)=  .4634458E-01
          SXSI(5)= -.1857721E-01
I= 71 SAMG= 0.          XXX= 0.          CP= -.3750000E+00 BETAM= 0.
```

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I= 70 SARG= .2427763E-03 XXX= .2427763E-03 CP= .9992459E+00 BETAN= 0.
I= 69 SARG= .7733153E-03 XXX= .7733153E-03 CP= .9767013E+00 BETAN= 0.
I= 68 SARG= .1416546E-02 XXX= .1416546E-02 CP= .9266227E+00 BETAN= 0.
I= 67 SARG= .2198029E-02 XXX= .2198029E-02 CP= .8731072E+00 BETAN= 0.
I= 66 SARG= .3097978E-02 XXX= .3097978E-02 CP= .8309062E+00 BETAN= 0.
I= 65 SARG= .4107662E-02 XXX= .4107662E-02 CP= .7937866E+00 BETAN= 0.
I= 64 SARG= .5218159E-02 XXX= .5218159E-02 CP= .7610091E+00 BETAN= 0.
I= 63 SARG= .6421759E-02 XXX= .6421759E-02 CP= .7319864E+00 BETAN= 0.
I= 62 SARG= .7711633E-02 XXX= .7711633E-02 CP= .7056536E+00 BETAN= 0.
I= 61 SARG= .9081620E-02 XXX= .9081620E-02 CP= .6824023E+00 BETAN= 0.
I= 60 SARG= .1052613E-01 XXX= .1052613E-01 CP= .6611552E+00 BETAN= 0.
I= 59 SARG= .1204063E-01 XXX= .1204063E-01 CP= .6417990E+00 BETAN= 0.
I= 58 SARG= .1361956E-01 XXX= .1361956E-01 CP= .6240781E+00 BETAN= 0.
I= 57 SARG= .1525733E-01 XXX= .1525733E-01 CP= .6077812E+00 BETAN= 0.
I= 56 SARG= .1695026E-01 XXX= .1695026E-01 CP= .5927355E+00 BETAN= 0.
I= 55 SARG= .1869952E-01 XXX= .1869952E-01 CP= .5787927E+00 BETAN= 0.
I= 54 SARG= .2049855E-01 XXX= .2049855E-01 CP= .5658299E+00 BETAN= 0.
I= 53 SARG= .2233701E-01 XXX= .2233701E-01 CP= .5537421E+00 BETAN= 0.
I= 52 SARG= .2422077E-01 XXX= .2422077E-01 CP= .5424392E+00 BETAN= 0.
I= 51 SARG= .2614389E-01 XXX= .2614389E-01 CP= .5318438E+00 BETAN= 0.
I= 50 SARG= .2810362E-01 XXX= .2810362E-01 CP= .5218884E+00 BETAN= 0.
I= 49 SARG= .3009734E-01 XXX= .3009734E-01 CP= .5125144E+00 BETAN= 0.
I= 48 SARG= .3212269E-01 XXX= .3212269E-01 CP= .5036705E+00 BETAN= 0.
I= 47 SARG= .3417719E-01 XXX= .3417719E-01 CP= .4953111E+00 BETAN= 0.
I= 46 SARG= .3625886E-01 XXX= .3625886E-01 CP= .4873964E+00 BETAN= 0.
I= 45 SARG= .3836559E-01 XXX= .3836559E-01 CP= .4798906E+00 BETAN= 0.
I= 44 SARG= .4049545E-01 XXX= .4049545E-01 CP= .4727620E+00 BETAN= 0.
I= 43 SARG= .4264685E-01 XXX= .4264685E-01 CP= .4659820E+00 BETAN= 0.
I= 42 SARG= .4481748E-01 XXX= .4481748E-01 CP= .4595253E+00 BETAN= 0.
I= 41 SARG= .4700632E-01 XXX= .4700632E-01 CP= .4533686E+00 BETAN= 0.
I= 40 SARG= .4921164E-01 XXX= .4921164E-01 CP= .4474913E+00 BETAN= 0.
I= 39 SARG= .5143007E-01 XXX= .5143007E-01 CP= .4418743E+00 BETAN= 0.
I= 38 SARG= .5366419E-01 XXX= .5366419E-01 CP= .4365026E+00 BETAN= 0.
I= 37 SARG= .5591275E-01 XXX= .5591275E-01 CP= .4313545E+00 BETAN= 0.
I= 36 SARG= .5817055E-01 XXX= .5817055E-01 CP= .4264217E+00 BETAN= 0.
I= 35 SARG= .6043425E-01 XXX= .6043425E-01 CP= .4216902E+00 BETAN= 0.
I= 34 SARG= .6271537E-01 XXX= .6271537E-01 CP= .4171480E+00 BETAN= 0.
I= 33 SARG= .6500182E-01 XXX= .6500182E-01 CP= .4127776E+00 BETAN= 0.
I= 32 SARG= .6729232E-01 XXX= .6729232E-01 CP= .4085678E+00 BETAN= 0.
I= 31 SARG= .6958549E-01 XXX= .6958549E-01 CP= .4045087E+00 BETAN= 0.
I= 30 SARG= .7188006E-01 XXX= .7188006E-01 CP= .4005912E+00 BETAN= 0.
I= 29 SARG= .7417485E-01 XXX= .7417485E-01 CP= .3968074E+00 BETAN= 0.
I= 28 SARG= .7646874E-01 XXX= .7646874E-01 CP= .3931504E+00 BETAN= 0.
I= 27 SARG= .7876055E-01 XXX= .7876055E-01 CP= .3896139E+00 BETAN= 0.
I= 26 SARG= .8104921E-01 XXX= .8104921E-01 CP= .3861922E+00 BETAN= 0.
I= 25 SARG= .8333359E-01 XXX= .8333359E-01 CP= .3828800E+00 BETAN= 0.
I= 24 SARG= .8561262E-01 XXX= .8561262E-01 CP= .3796724E+00 BETAN= 0.
I= 23 SARG= .8788522E-01 XXX= .8788522E-01 CP= .3765647E+00 BETAN= 0.
I= 22 SARG= .9015035E-01 XXX= .9015035E-01 CP= .3735525E+00 BETAN= 0.
I= 21 SARG= .9240695E-01 XXX= .9240695E-01 CP= .3706317E+00 BETAN= 0.
I= 20 SARG= .9465402E-01 XXX= .9465402E-01 CP= .3677983E+00 BETAN= 0.
I= 19 SARG= .9689057E-01 XXX= .9689057E-01 CP= .3650487E+00 BETAN= 0.
I= 18 SARG= .9911563E-01 XXX= .9911563E-01 CP= .3623793E+00 BETAN= 0.
I= 17 SARG= .1013282E+00 XXX= .1013282E+00 CP= .3597869E+00 BETAN= 0.
I= 16 SARG= .1035286E+00 XXX= .1035286E+00 CP= .3572683E+00 BETAN= 0.
I= 15 SARG= .1057159E+00 XXX= .1057159E+00 CP= .3548206E+00 BETAN= 0.
I= 14 SARG= .1078894E+00 XXX= .1078894E+00 CP= .3524410E+00 BETAN= 0.
I= 13 SARG= .1100484E+00 XXX= .1100484E+00 CP= .3501269E+00 BETAN= 0.
I= 12 SARG= .1121922E+00 XXX= .1121922E+00 CP= .3478758E+00 BETAN= 0.
I= 11 SARG= .1143201E+00 XXX= .1143201E+00 CP= .3456854E+00 BETAN= 0.
I= 10 SARG= .1164317E+00 XXX= .1164317E+00 CP= .3435535E+00 BETAN= 0.
I=  9 SARG= .1185262E+00 XXX= .1185262E+00 CP= .3414779E+00 BETAN= 0.
I=  8 SARG= .1206031E+00 XXX= .1206031E+00 CP= .3394566E+00 BETAN= 0.
I=  7 SARG= .1226619E+00 XXX= .1226619E+00 CP= .3374877E+00 BETAN= 0.
I=  6 SARG= .1247019E+00 XXX= .1247019E+00 CP= .3355693E+00 BETAN= 0.
I=  5 SARG= .1267226E+00 XXX= .1267226E+00 CP= .3336999E+00 BETAN= 0.
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I=  5 SARC=  .[illegible]  XXX=  .9593951E+00 CP=  .2470711E+00 BETAN= 0.
I=  4 SARC=  .9593951E+00 XXX=  .9593951E+00 CP=  .2470711E+00 BETAN= 0.
I=  3 SARC=  .9734664E+00 XXX=  .9734664E+00 CP=  .2481766E+00 BETAN= 0.
I=  2 SARC=  .9870866E+00 XXX=  .9870866E+00 CP=  .2495849E+00 BETAN= 0.
I=  1 SARC=  .1000002E+01 XXX=  .1000002E+01 CP=  .2528905E+00 BETAN= 0.
      I=  1 SARC2= 0.              XXX2=  .9679643E+00 CP2= -.3750000E+00 BETAN2= -.3141593E+01
      I=  2 SARC2=  .4442823E-02 XXX2=  .9724069E+00 CP2=  .9968768E+00 BETAN2= -.3141593E+01
      I=  3 SARC2=  .[illegible] XXX2=  .9768496E+00 CP2=  .9810322E+00 BETAN2= -.3141593E+01
      I=  4 SARC2=  .1054[illegible]E-01 XXX2=  .9735532E+00 CP2=  .9579241E+00 BETAN2= -.3141593E+01
      I=  5 SARC2=  .1222[illegible]E-01 XXX2=  .9802567E+00 CP2=  .9301148E+00 BETAN2= -.3141593E+01
      I=  6 SARC2=  .1339[illegible]E-01 XXX2=  .9813573E+00 CP2=  .9063011E+00 BETAN2= -.3141593E+01
      I=  7 SARC2=  .1449[illegible]E-01 XXX2=  .9824580E+00 CP2=  .8807853E+00 BETAN2= -.3141593E+01
      I=  8 SARC2=  .1557[illegible]E-01 XXX2=  .9833591E+00 CP2=  .8561452E+00 BETAN2= -.3141593E+01
      I=  9 SARC2=  .1665[illegible]E-01 XXX2=  .9842203E+00 CP2=  .8325175E+00 BETAN2= -.3141593E+01
      I= 10 SARC2=  .1701972E-01 XXX2=  .9849840E+00 CP2=  .8099248E+00 BETAN2= -.3141593E+01
      I= 11 SARC2=  .1778344E-01 XXX2=  .9857478E+00 CP2=  .7883352E+00 BETAN2= -.3141593E+01
      I= 12 SARC2=  .1884724E-01 XXX2=  .9864368E+00 CP2=  .7676920E+00 BETAN2= -.3141593E+01
      I= 13 SARC2=  .1991615E-01 XXX2=  .9871258E+00 CP2=  .7479281E+00 BETAN2= -.3141593E+01
      I= 14 SARC2=  .1977[illegible]E-01 XXX2=  .9877624E+00 CP2=  .7289741E+00 BETAN2= -.3141593E+01
      I= 15 SARC2=  .2043458E-01 XXX2=  .9883985E+00 CP2=  .7107617E+00 BETAN2= -.3141593E+01
      I= 16 SARC2=  .2103172E-01 XXX2=  .9889960E+00 CP2=  .6932257E+00 BETAN2= -.3141593E+01
      I= 17 SARC2=  .2162[illegible]E-01 XXX2=  .9895932E+00 CP2=  .6763044E+00 BETAN2= -.3141593E+01
      I= 18 SARC2=  .2219497E-01 XXX2=  .9901597E+00 CP2=  .6599401E+00 BETAN2= -.3141593E+01
      I= 19 SARC2=  .2276107E-01 XXX2=  .9907254E+00 CP2=  .6440785E+00 BETAN2= -.3141593E+01
      I= 20 SARC2=  .2330[illegible]E-01 XXX2=  .9912662E+00 CP2=  .6286684E+00 BETAN2= -.3141593E+01
      I= 21 SARC2=  .2382[illegible]E-01 XXX2=  .9918069E+00 CP2=  .6139617E+00 BETAN2= -.3141593E+01
      I= 22 SARC2=  .2436[illegible]E-01 XXX2=  .9923264E+00 CP2=  .5996120E+00 BETAN2= -.3141593E+01
      I= 23 SARC2=  .2488[illegible]E-01 XXX2=  .9929459E+00 CP2=  .5848750E+00 BETAN2= -.3141593E+01
      I= 24 SARC2=  .2538[illegible]E-01 XXX2=  .9933470E+00 CP2=  .5705070E+00 BETAN2= -.3141593E+01
      I= 25 SARC2=  .2589[illegible]E-01 XXX2=  .9938481E+00 CP2=  .5567648E+00 BETAN2= -.3141593E+01
      I= 26 SARC2=  .2636[illegible]E-01 XXX2=  .9943331E+00 CP2=  .5431047E+00 BETAN2= -.3141593E+01
      I= 27 SARC2=  .2685[illegible]E-01 XXX2=  .9948191E+00 CP2=  .5295[illegible]E+00 BETAN2= -.3141593E+01
      I= 28 SARC2=  .2732[illegible]E-01 XXX2=  .9952885E+00 CP2=  .5161[illegible]E+00 BETAN2= -.3141593E+01
      I= 29 SARC2=  .2779[illegible]E-01 XXX2=  .9957598E+00 CP2=  .5027523E+00 BETAN2= -.3141593E+01
      I= 30 SARC2=  .2825[illegible]E-01 XXX2=  .9962161E+00 CP2=  .4893372E+00 BETAN2= -.3141593E+01
      I= 31 SARC2=  .2870[illegible]E-01 XXX2=  .9966773E+00 CP2=  .4758371E+00 BETAN2= -.3141593E+01
      I= 32 SARC2=  .2915[illegible]E-01 XXX2=  .9971180E+00 CP2=  .4621740E+00 BETAN2= -.3141593E+01
      I= 33 SARC2=  .2959[illegible]E-01 XXX2=  .9975627E+00 CP2=  .4482821E+00 BETAN2= -.3141593E+01
      I= 34 SARC2=  .3001[illegible]E-01 XXX2=  .9979954E+00 CP2=  .4339[illegible]E+00 BETAN2= -.3141593E+01
      I= 35 SARC2=  .3044[illegible]E-01 XXX2=  .9984[illegible]E+00 CP2=  .4193[illegible]E+00 BETAN2= -.3141593E+01
      I= 36 SARC2=  .3084[illegible]E-01 XXX2=  .9988490E+00 CP2=  .4034717E+00 BETAN2= -.3141593E+01
      I= 37 SARC2=  .3126[illegible]E-01 XXX2=  .9992[illegible]E+00 CP2=  .3[illegible]E+00 BETAN2= -.3141593E+01
      I= 38 SARC2=  .3171[illegible]E-01 XXX2=  .9996773E+00 CP2=  .3682101E+00 BETAN2= -.3141593E+01
      I= 39 SARC2=  .3212[illegible]E-01 XXX2=  .1000094E+01 CP2=  .3412[illegible]E+00 BETAN2= -.3141593E+01
      I= 40 SARC2=  .3251[illegible]E-01 XXX2=  .1000477E+01 CP2=  .3154[illegible]E+00 BETAN2= -.3141593E+01
      I= 41 SARC2=  .3290[illegible]E-01 XXX2=  .1000[illegible]E+01 CP2=  .2[illegible]E+00 BETAN2= -.3141593E+01
CLIFF OF CUTOFF=[illegible]  CLIFF=  .7997406E+00 CDIAF=  .5862156E-01
FLAP IS [illegible] FROM TRAILING EDGE.
---CORE : [illegible] AXE BASED ON 61 IN ALPA1 DIRE.---
CDCE=  .1[illegible]E+00 CCIL=  .5468147E+00 L/D=  .6313752E+01
---CAVITY SHAPE---
          X=  0.                    Y=  0.
          X=  .1026[illegible]E-02          Y=  .1514021E-02
          X=  .5162[illegible]E-02          Y=  .4350535E-02
          X=  .1340[illegible]E-01          Y=  .9332170E-02
          X=  .2[illegible]E-01             Y=  .1557418E-01
          X=  .4[illegible]E-01             Y=  .2267773E-01
          X=  .7[illegible]E-01             Y=  .3[illegible]E-01
          X=  .1[illegible]E+00             Y=  .3[illegible]E-01
          X=  .1[illegible]E+00             Y=  .4[illegible]E-01
          X=  .1612317E+00                  Y=  .5779972E-01
          X=  .2[illegible]E+00             Y=  .6[illegible]E-01
          X=  .2[illegible]E+00             Y=  .7[illegible]E-01
          X=  .5[illegible]E+00             Y=  .8137602E-01
          X=  .[illegible]E+00              Y=  .8[illegible]E-01
          X=  .4077110E+00                  Y=  .9[illegible]E-01
          X=  .4[illegible]E+00             Y=  .9[illegible]E-01
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X=	.4A79897E+00	Y=	.1000120E+00
X=	.9245167E+00	Y=	.1026451E+00
X=	.[illegible]E+00	Y=	.1046471E+00
X=	.[illegible]E+00	Y=	.1061006E+00
X=	.[illegible]E+00	Y=	.1070779E+00
X=	.[illegible]E+00	Y=	.1076411E+00
X=	.[illegible]E+00	Y=	.1078424E+00
X=	.[illegible]E+00	Y=	.1077254E+00
X=	.[illegible]E+00	Y=	.1073295E+00
X=	.[illegible]E+00	Y=	.1066770E+00
X=	.[illegible]E+00	Y=	.1057905E+00
X=	.[illegible]E+00	Y=	.1046888E+00
X=	.[illegible]E+00	Y=	.1034095E+00
X=	.[illegible]E+00	Y=	.1019961E+00
X=	.[illegible]E+00	Y=	.1002645E+00
X=	.[illegible]E+00	Y=	.9842186E-01
X=	.[illegible]E+00	Y=	.9639441E-01
X=	.[illegible]E+00	Y=	.9417272E-01
X=	.[illegible]E+00	Y=	.9173948E-01
X=	.[illegible]E+00	Y=	.8906573E-01
X=	.[illegible]E+00	Y=	.8610344E-01
X=	.[illegible]E+00	Y=	.8276873E-01
X=	.[illegible]E+00	Y=	.7898603E-01
X=	.[illegible]E+00	Y=	.7466428E-01
X=	.[illegible]E+00	Y=	.6919692E-01

X=	0.00000	Y=	0.00000
X=	.02000	Y=	0.00000
X=	.04000	Y=	0.00000
X=	.06000	Y=	0.00000
X=	.08000	Y=	0.00000
X=	.10000	Y=	0.00000
X=	.12000	Y=	0.00000
X=	.14000	Y=	0.00000
X=	.16000	Y=	0.00000
X=	.18000	Y=	0.00000
X=	.20000	Y=	0.00000
X=	.22000	Y=	0.00000
X=	.24000	Y=	0.00000
X=	.26000	Y=	0.00000
X=	.28000	Y=	0.00000
X=	.30000	Y=	0.00000
X=	.32000	Y=	0.00000
X=	.34000	Y=	0.00000
X=	.36000	Y=	0.00000
X=	.38000	Y=	0.00000
X=	.40000	Y=	0.00000
X=	.42000	Y=	0.00000
X=	.44000	Y=	0.00000
X=	.46000	Y=	0.00000
X=	.48000	Y=	0.00000
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X=	.52000	Y=	0.00000
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X=	.66000	Y=	0.00000
X=	.68000	Y=	0.00000
X=	.70000	Y=	0.00000
X=	.72000	Y=	0.00000
X=	.74000	Y=	0.00000

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X=     .76000   Y=    0.00000
X=     .78000   Y=    0.00000
X=     .80000   Y=    0.00000
X=     .82000   Y=    0.00000
X=     .84000   Y=    0.00000
X=     .86000   Y=    0.00000
X=     .88000   Y=    0.00000
X=     .90000   Y=    0.00000
X=     .92000   Y=    0.00000
X=     .94000   Y=    0.00000
X=     .96000   Y=    0.00000
X=     .98000   Y=    0.00000
X=    1.00000   Y=    0.00000
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.1000000E+01 0.
.9[illegible]E+00 0.
.9774[illegible]E+00 0.
.9[illegible]E+00 0.
.9446414E+00 0.
.92[illegible]E+00 0.
.9141[illegible]E+00 0.
.8979[illegible]E+00 0.
.8810[illegible]E+00 0.
.8634287E+00 0.
.845[illegible]E+00 0.
.8256636E+00 0.
.8057377E+00 0.
.7845[illegible]E+00 0.
.7623[illegible]E+00 0.
.7358[illegible]E+00 0.
.713[illegible]E+00 0.
.6873790E+00 0.
.659[illegible]E+00 0.
.6287282E+00 0.
.5960018E+00 0.
.5605022E+00 0.
.5217242E+00 0.
```

.4790159E+00	0.
.4315216E+00	0.
.3750955E+00	0.
.3172135E+00	0.
.2488474E+00	0.
.1648037E+00	0.
.7159358E-01	0.
.6959049E-01	0.
.6729232E-01	0.
.6560632E-01	0.
.6271537E-01	0.
.6043848E-01	0.
.5817058E-01	0.
.5591275E-01	0.
.5365415E-01	0.
.5143267E-01	0.
.4921186E-01	0.
.4709632E-01	0.
.4481748E-01	0.
.4284685E-01	0.
.4049548E-01	0.
.3836556E-01	0.
.3625685E-01	0.
.3417718E-01	0.
.3212283E-01	0.
.3009734E-01	0.
.2710381E-01	0.
.2614375E-01	0.
.2422077E-01	0.
.2233763E-01	0.
.2049555E-01	0.
.1869958E-01	0.
.1695228E-01	0.
.1525773E-01	0.
.1361858E-01	0.
.1204007E-01	0.
.1052813E-01	0.
.9081522E-02	0.
.7711532E-02	0.
.6401758E-02	0.
.5214188E-02	0.
.4107887E-02	0.
.3097578E-02	0.
.2178025E-02	0.
.1415549E-02	0.
.7735153E-03	0.
.2837783E-03	0.
0.	0.
0.	-.3141593E+01
.4442658E-02	-.3141593E+01
.5849248E-02	-.3141593E+01
.1058683E-01	-.3141593E+01
.1229241E-01	-.3141593E+01
.1339362E-01	-.3141593E+01
.1449363E-01	-.3141593E+01
.1537428E-01	-.3141593E+01
.1625660E-01	-.3141593E+01
.1701972E-01	-.3141593E+01
.1778349E-01	-.3141593E+01
.1847247E-01	-.3141593E+01
.1916156E-01	-.3141593E+01
.1979604E-01	-.3141593E+01
.2043458E-01	-.3141593E+01
.2103172E-01	-.3141593E+01
.2162886E-01	-.3141593E+01
.2219437E-01	-.3141593E+01

```
.22761375E+01 -.31415938E+01
.23591698E+01 -.31415938E+01
.24421822E+01 -.31415938E+01
.25252045E+01 -.31415938E+01
.26082268E+01 -.31415938E+01
.26912491E+01 -.31415938E+01
.27742614E+01 -.31415938E+01
.28572837E+01 -.31415938E+01
.29403060E+01 -.31415938E+01
.30233183E+01 -.31415938E+01
.31063406E+01 -.31415938E+01
.31893629E+01 -.31415938E+01
.32723852E+01 -.31415938E+01
.33554075E+01 -.31415938E+01
.34384198E+01 -.31415938E+01
.35214421E+01 -.31415938E+01
.36044644E+01 -.31415938E+01
.36874867E+01 -.31415938E+01
.37705090E+01 -.31415938E+01
```

5.0 LISTING OF PCAS

```
      PROGRAM PCAS(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE7,TAPE1)
C  NONLINEAR PARTIALLY CAVITATING CASCADE CALCULATIONS.
C  5/17/1978 PROGRAMMED BY J. FURUYA.
      DIMENSION XBE(5),XZ(5),BETANC(513),BETAMJ(513),BETAD2(100)
      DIMENSION SXSI(5),XXX(513),CP(513),INT(10),XCP(5),YCP(5)
      DIMENSION FL(200),FD(200),CP2(101),XXX2(201),FL2(100),FD2(100)
      COMMON/DELTAD/DELT(5,5)
      COMMON/THICK/TH
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,YCCC,NCAV,LPMM,MS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON SIGMA,SBETA,XXM,ICPI,SARCOC(513)
      COMMON IOJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSM(5),CCC1,CLE,ERC,YYY,XM,IIEPA,SXSIC(5),SYSICC(5),YXS(5)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XBX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
C BETAN-----FOR ARC 1  FOR REGULAR INTEGRAL.
C BBTAN IS FOR INTERPOLATED VERSION OF BETAN .
C BETAN2 FOR EQUALLY SPACED INCREMENT FOR ARC 2.
C BBTAN2 FOR CHEBYCHEV- GAUSS VERSION OF BETAN2.
      PAI=3.141592653
      READ(5,795) NGAUS
      NGAUS1=NGAUS+1
      NNN2=NGAUS/2
      NGAUS2=NNN2+1
      READ(5,560) (TGAUS(I),I=NGAUS2,NGAUS)
      READ(5,560) (WGAUS(I),I=NGAUS2,NGAUS)
      DO 26 IQ=1,NNN2
      TGAUS(IQ)=-TGAUS(NGAUS1-IQ)
   26 WGAUS(IQ)=WGAUS(NGAUS1-IQ)
      WRITE(6,561) (TGAUS(I),I=NGAUS2,NGAUS)
      WRITE(6,562) (WGAUS(I),I=NGAUS2,NGAUS)
  560 FORMAT(4F20.10)
  561 FORMAT(1X,*T(I)=*,10(F10.8,1X))
      READ (5,590) XXM


      DO 589 IDELTA=1,5
  589 READ (5,590) (DELT(IDELTA,I),I=1,5)
  562 FORMAT(1X,*W(I)=*,10(F10.8,1X))


      READ(5,560) TH
      READ(5,560) R,AAAA,BBBB,CCCC
      READ(5,560) AB,BB,CB,DB
      READ(5,560) XROUND,A2AA,B2BB,C2CC
      READ(5,795) IFLAG1 ,NCHBY
      READ(5,1321) SBETA ,SBETA2,SF4,BETA3,BETAC
      READ(5,551) LPMS,LPKS,LPM2,IFLAG,IREAD,ISHARP
      READ(5,201) NITER,MSTOP,MAXIT,NHK
      READ(5,202) ALFAIS,GAMMAS,SOLIS,   SIGMS
      READ(5,229) DE,DG,DF
      DO 592 IDELTA=1,5
  592 WRITE (6,591) (DELT(IDELTA,I),I=1,5)
```

```
      WRITE (6,5590) TH,XXM
      WRITE(6,5651) BETAB,BETAC
      WRITE(6,565) R,AAAA,BBBB,CCCC
      WRITE(6,566) A8,B8,C8,D8
      WRITE(6,567) XROUND,A2AA,B2BB,C2CC
      WRITE(6,1229) LPMS,LPKS,SBETA,IREAD,NCHBY
      WRITE(6,1324) DE,DG,DF,SF4
      WRITE(6,1321) SBETA2
  590 FORMAT (8F10.8)
  591 FORMAT (10X,*DELTA(I,J)=*,5(F10.8,2X))
 5590 FORMAT (20X,*THICKNESS OF PLANO CONVEX FOIL = *,F10.5,10X,*XXM=*,
     1F10.5)
  565 FORMAT(20X,*R=*,F5.2,2X,*AAAA=*,F10.6,2X,*BBBB=*,F10.6,2X,*CCCC=*,
     XF10.6)
  566 FORMAT(20X,*A8=*,F10.6,2X,*B8=*,F10.6,2X,*C8=*,F10.6,2X,*D8=*,F10.
     X6)
  567 FORMAT(20X,*XROUND=*,F10.6,2X,*A2AA=*,F10.6,2X,*B2BB=*,F10.6,2X,*C
     X2CC=*,F10.6)
C  IFLAG+++++IFLAG=1 FOR THE FIRST RUN & IFLAG=0 FOR PREVIOUS DATA USE.
C IFLAG1=0 FOR REGULAR RUNS, IFLAGNE0FOR RUNS OF READING DATA FROM CASCLIM.
C IF IFLAGNE.0 NEED EXTRA DATA FOR SXSI(2) AND SXSI(3).
  795 FORMAT(8I10)
C AAAA,BBBB,CCCCARE CONSTANTS FOR 2-TERM CAMBER, X AND SQRT(X)
C  --------CALCULATED FROMANOTHER PROGRAM CALLED *CAMBER*---------.
C A8,B8,C8 AND D8 ARE COEFFICIENTS FOR POLYNOMIALS FOR X GREATER THAN .8.
C CLDD AND CLDDK ARE NOW DUMMY.
C SF4 IS USED FOR DETERMINING WHETHER TO CALCULATE BETA.
 1321 FORMAT(5E14.7)
C IFLAG=1 NEEDS DATA CARDS FOR SXSI(I), I=1,5, IREAD MAY BE SET TO 5.
C IF IFLAG=0 , DATA WILL BE READ EITHER FROM
C         DATA CARD, IF IREAD=5
C         TAPE1    , IF IREAD=1.
  551 FORMAT(10I8)
  201 FORMAT(4I8)
  202 FORMAT(4E14.7)
C DE,DG,DF ARE THE INCREMENTS FOR DERIVATIVES IN OXFNEW.
C DG=1.E-5 & DF=1.E-5 ARE USED BEFORE.
  229 FORMAT(3E14.7)
 1229 FORMAT(5X,4HLPM=,I4,2X,4HLPK=,I4,2X,6HSBETA=,E14.7,5X,6HIREAD=,I1,
     X2X,*NCHBY=*,I3)
 5651 FORMAT(20X,*BETAB AND BETAC AS FIRST GUESS=*,F10.5,2X,F10.5)
 1324 FORMAT(10X,3HDE=,E14.7,2X,3HDG=,E14.7,3HDF=,E14.7,2X,4HSF4=,E14.7)
 1321 FORMAT(10X,*SBETA2=*,E14.7)
      SBETA2=SBETA2*PAI/180.
      BETAB=BETAB*PAI/180.
      BETAC=BETAC*PAI/180.
C  LPMM=LPM2=NS2
      LPMM=LPM2
      NS2=LPM2
      LPMM1=LPMM+1
      WRITE(6,1499) LPM2,ISHARP
 1499 FORMAT(10X,*LPM2=*,I3,2X,*ISHARP=*,E14.7)
C ISHARP=0 FOR SHARP L.E.
C         1 FOR ROUNDED L.E.
      SBETA=SBETA*PAI/180.
      DO 999 IJKL=1,NITER
C FFF4 IS PROVIDED FROM OXFNEW, BUT IF THE LOOP DOES NOT GO THROUTH
C     IT, FFF4 OF PRESET VALUE MUST BE USED.
      FFF4=0.
      ALFA1O=ALFA1S
```

```
      GAMMAD=GAMMAS
      SOLID=SOLIS
      SIGMA=SIGMS
      IF(NHK.EQ.1) GO TO 240
      IF(NHK.EQ.2) GO TO 241
      IF(NHK.EQ.3) GO TO 242
      SIGMA=SIGMS-0.01*FLOAT(IJKL-1)
      GO TO 243
  242 SOLID=SOLIS+0.1*FLOAT(IJKL-1)
      GO TO 243
  241 GAMMAD=GAMMAS+2.*FLOAT(IJKL-1)
      GO TO 243
  240 ALFA1D=ALFA1S-2.*FLOAT(IJKL-1)
  243 CONTINUE
      XM=XXM
      ALFA1=ALFA1D*PAI/180.
      DGAP=1./SOLID
      GAMMA=GAMMAD*PAI/180.
      DELTA=ALFA1+GAMMA
      FLAPAN=0.
      WRITE(6,666) ALFA1D,GAMMAD,SOLID
  666 FORMAT(1X,16HINCIDENCE ANGLE=,E14.7,1X,6HGAMMA=,E14.7,1X,9HSOLIDIT
     XY=,E14.7)
      WRITE(6,663) FLAPAN
  663 FORMAT(5X,11HFLAP ANGLE=,E14.7)
      STOLL=2.E-4
      STOLS=5.E-4
      ERC=1.E-2
      CLE=1.E-4
C CAVIT. NO.=SIGMA, AND PSIZ.
      WRITE(6,511) SIGMA
  511 FORMAT(10X,11HCAVIT. NO =,E14.7)
      CCC1=ALOG(1.+SIGMA)/(2.*PAI)
C SPECIFY HYDROFOILTS CHARACTERISTICS AND SEP. POINTS.
      XC=0.
      YC=0.
      XB=0.
      XA=1.
      WRITE(6,502)XA,XB,XC,YC
  502 FORMAT(10X,9HCHORD=,E14.7,2X,17HUPPER SEP. POINT=,E14.7,2X,20HCONN
     X. POINT(XC,YC)=(,E14.7,1H,,E14.7,1H))
C START ITERATIVE PROCEDURE.
C      -----BASIC FLOW IS THAT OF FLAT PLATE-----.
C ITERAT IS INDEX FOR NUMBER OF ITERATIONS.
      ITERA=1
      IF(IFLAG.EQ.0) ITERA=2
      IF(IFLAG.EQ.0) IREAD=1
      BIGS=0.
      XHIGH=0.
      XLOW=0.
      XINCRT=XA/50.
      DO 248 IINC=1,50
      XLOW=XHIGH
      XHIGH=XLOW+XINCRT
      CALL ARCLEN(S,XLOW,XHIGH)
  248 BIGS=BIGS+S
      WRITE(6,504) BIGS
  504 FORMAT(10X,5HBIGS=,E14.7)
      STOL=1.E-5
      LPM=LPMS
```

```
      LPK=LPKS
      LPM1=LPM-1
      LPM3=LPM-3
C ICPI IS USED FOR CONTROLLING PROGRAM; 0 FOR ITER. 1 FOR THE REST.
C FIND XSIB,XSIC,XSIF,A,ALFA2 BY USING NEWTON,S METHOD.
C SXSI(1)=XSIB
C SXSI(2)=XSIC
C SXSI(3)=XSIF
C SXSI(4)=A WHICH IS THE COEFFT. OF MAPPING FCN.
C SXSI(5)=ALF2
      IF(IJKL.GE.2) GO TO 630
      IF(IFLAG.EQ.0) GO TO 761
C INATIAL GUESS FOR SXSI(I) IS ----------
      READ(5,764) SXSI(1),SXSI(2),SXSI(3),SXSI(4),SXSI(5)
      GO TO 160
C THIS IS THE CASE THAT OLD DATA ARE USED WITH PUNCHED CARDS.
  761 CONTINUE
      IF(IFLAG1.EQ.0) GO TO 779
      READ(1,620) SXSI(1),SXSI(2),SXSI(3),SXSI(4)
      SXSI(5)=SXSI(3)
      READ(5,778) SXSI(2),SXSI(3)
  778 FORMAT(2E14.7)
      GO TO 629
  779 READ(IREAD,620) SXSI(1),SXSI(2),SXSI(3),SXSI(4),SXSI(5)
  620 FORMAT(5E14.7)
  629 DO 621 IC=1,LPM
  621 READ(IREAD,622) SARC(IC),BETAN(IC)
  622 FORMAT(2E14.7)
      DO 1621 IC=1,LPMM1
 1621 READ(IREAD,622) SARC2(IC),BETAN2(IC)
      IF(IFLAG.EQ.0) GO TO 480
      GO TO 481
  480 DO 482 IBT=1,LPM1
  482 BETAM(IBT)=.5*(BETAN(IBT)+BETAN(IBT+1))
  481 CONTINUE
  160 ICPI=0
      WRITE(6,102) ITERA
  102 FORMAT(10X,14HITERATION NO.=,I2)
      DO 850 IRP=1,5
  850 SXSIO(IRP)=SXSI(IRP)
      IF(ITERA.GE.2) STOL=STOLS
      IF(ITERA.EQ.MSTOP) STOL=STOLL
C
C
C
C
      CALL OXFREV(SXSI,STOL,MAXIT,ITN,OG,OF,FFF4)
C
C
C
C
  630 CONTINUE
      DO 537 I01=1,5
      XSR(I01)=SXSI(I01)
  537 WRITE(6,536) I01,SXSI(I01)
  536 FORMAT(10X,5HSXSI(,I1,2H)=,E14.7)
      CSPACE=(1.+SXSI(1))/FLOAT(LPK)
      HCSPAC=0.5*CSPACE
      FSPACE=CSPACE/FLOAT(LPM-LPK)
      HFSPAC=0.5*FSPACE
```

```
      XBET=-1.+CSPACE*FLOAT(LPK-1)
      ICPI=1
C ICPI=0 FOR FINDING SXSI(I), I.E., SXSI(I)=YYS(I)≥ ICPI=1 FOR THE REST.
C CALCULATION OF PRESSURE DISTRIBUTION ICPI.
      IF(ITERA.EQ.1) GO TO 36
      DO 35 IB=1,LPM
   35 BETAMO(IB)=BETAM(IB)
      DO 37 IB=1,LPM1
   37 BETAMO(IB)=BETAM(IB)
      DO 355 IB=1,LPMM1
  355 BETAO2(IB) = BETAM2(IB)
   36 CONTINUE
      UU2=COS(ALFA1+GAMMA)/COS(SXSI(5)+GAMMA)
      UU22=UU2**2
      DO 25 LG=1,LPM
      LP=LG
C FIND CP(XSIP) NEXT.
C----- FOR THE FIRST BETTED ARC PORTION S1-----
C     CP IS BASED  ON U1 AND P1.
C     LP=1 IS NEAR THE T.E.
C     LP=LPM IS NEAR THE L.E.
      IF(LP.EQ.1)  GO TO 521
      IF(LP.EQ.LPM) GO TO 52
      Q2=EXP(XITN(LP))
C XITN(I) IS CALCULATED IN OFSIM2 OF OXFNE, FOR F(4).
      Q2=Q2**2
      CP(LP)=1.-UU22*Q2
      GO TO 522
   52 CP(LP)=-SIGMA
      GO TO 522
  521 CP(LP)=1.-UU22
  522 CONTINUE
   25 CONTINUE
C                                                                  EUNITNOC 431
C                                                                 .0=)4P_(PC
C                                                )3,021X,PCY,PCX(NEKTIA=)1-MPL(PC
C                                                )3,911X,PCY,PCX(NEKTIA=)2-MPL(PC
C                                                        ECAPSF-)1(ISXS=021X
C                                                ECAPSF*,2-)1(ISXS=911X
C                                                        .0=)4(PCY
C                                                    )3-MPL(PC=)3(PCY
C                                                    )5-MPL(PC=)2(PCY
C                                                    )7-MPL(PC=)1(PCY
C                                                      )1(ISXS=)4(PCY
C                                                ECAPSF*.2+)2(PCX=)3(PCX
C                                                ECAPSF*.2+)1(PCX=)2(PCX
C                                               ECAPSF*,7-)1(ISXS=)1(PCX
C                                               431 OF DG )1.GE.ARETI(FI
C                                                                          *
C
C*********MAIN INSERT 1*************************************************
C                                                                          *
C                                                                          *
C------Cr FOR THE SECOND ARC S2-------
C        NUMBER OF CONTROL POINTS ON S2 IS FIXED
C        IN SUBROUTINE OFSIM5, I.E.,
C           HALF OF THE POINT USED FOR BETA
C        ANSG2S IN COMMON = G2.
      DO 680 NCP = 1,LPMM1
      IF(NCP.EQ.1) GO TO 681
```

```
      IF (NCP.EQ.LPMM1) GO TO 682
      Q2 = EXP(ANSG2S(NCP))
      G2 = G2**2
      CP2(NCP) = 1.-G2*UU22
      GO TO 680
  681 CP2(NCP) = -SIGMA
      GO TO 680
  682 CP2(NCP) = 1.-UU22
  680 CONTINUE
C                                                                              *
C                                                                              *
C*********MAIN INSERT 1*************************************************************
C
C
      AF4=ABS(FFF4)
      IF(AF4.GE.SF4) GO TO 1135
      GO TO 1134
 1135 WRITE(6,1136)
 1136 FORMAT(5X,*F(4) IS TOO LARGE TO CALCULATE BETA*)
      STOP
C FIND XXX(XSIP) FIRST.
 1134 CONTINUE
      IS1S2=0
C-----FIRST BETA FOR ARC 1-----.
      DO 100 LLP=1,LPM
      LP=LPM-LLP+1
      CALL BBBETA(XYX,BETA,IS1S2)
      XXX(LP)=XYX
      BETAN(LP)=BETA
      IF(LP.EQ.LPM) BETAB=BETA
      IF(ITERA.LE.MSTOP1) GO TO 100
      WRITE(6,101) LP,SARC(LP),XXX(LP),CP(LP),BETAN(LP)
  100 CONTINUE
  101 FORMAT(1X,2HI=,I3,1X,5HSARC=,E14.7,1X,4HXXX=,E14.7,1X,3HCP=,E14.7,
     X1X,6HBETAN=,E14.7)
C
C
C*********MAIN INSERT 2*************************************************************
C                                                                              *
C                                                                              *
C----------BETA FOR ARC S2-------------------------.
C             SARC2 HAS BEEN CALCULATED
C             IN SUBROUTINE DFSIMS AND
C             STORED IN COMMON AREA.
      IS1S2 = 1
      DO 429 LLP=1,LPMM1
      LP=LLP
      CALL BBBETA(XYX,BETA,IS1S2)
      IF(LP.EQ.1) BETAC=BETA
      XXX2(LP) = XYX
      BETAN2(LP) = BETA
      IF(ITERA.LE.MSTOP1) GO TO 329
      WRITE(6,239) LP,SARC2(LP),XXX2(LP),CP2(LP),BETAN2(LP)
  239 FORMAT(9X,*I=*,I3,1X,*SARC2=*,E14.7,1X,*XXX2=*,
     *E14.7,1X,*CP2=*,E14.7,1X,*BETAN2=*,E14.7)
  329 CONTINUE
  429 CONTINUE
C                                                                              *
C                                                                              *
C*********MAIN INSERT 2*************************************************************
```

```
C
C
C*********MAIN INSERT 3 ***********************************************************
C                                                                                    *
C                                                                                    *
C FIND LIFT AND DRAG.
C----------FIRST CL AND CD FOR S1 PART.
      USID = SIN(DELTA)
      UCOD = COS(DELTA)
      UXB = SXSI(4)*UCOD
      UXB2 = UXB**2
      DO 105 ITK = 1,LPM
      IF(ITK.GT.LPK) GO TO 106
      XPS = -1.*CSPACE*FLOAT(ITK-1)
      GO TO 108
  106 XPS = XBET+FSPACE*FLOAT(ITK-LPK)
  108 CONTINUE
      UXA = XPS-SXSI(4)*USID
      UXA2 = UXA**2
      PXXP = UCOD/(UXA2+UXB2)
      DWDX = DGAP*PXXP*XPS/PAI
      COBET1      = COS(BETAN(ITK))
      SIBET1      = SIN(BETAN(ITK))
      DS1DX = -EXP(-XITN(ITK))*DWDX/UU22
C     S1 IS CALCULATED AT OFSIM2 AS XITN(I).
C     AND STORED IN COMMON.
      IF(XPS.LT.0.) DS1DX = -DS1DX
      XLP1 = DS1DX*CP(ITK)
      FL(ITK) = -XLP1*COBET1
      FD(ITK) = XLP1*SIBET1
  105 CONTINUE
C-----CL AND CD FOR S2 PART.
      NS21=NS2+1
      NS2A=NS2-1
      GAP2 = (SXSI(3)-SXSI(2))/NS2
      DO 338 ITK = 1, NS21
      XRS2 = SXSI(2)+GAP2*(ITK-1)
      UXA = XRS2-SXSI(4)*USID
      UXA2 = UXA**2
      PXXP = UCOD/(UXA2+UXB2)
      DWDX = DGAP*PXXP*XRS2/PAI
      COBET2 =-COS(BETAN2(ITK))
      SIBET2 =-SIN(BETAN2(ITK))
      DS2DX = EXP(-ANSG2S(ITK))*DWDX/UU22
C     S2 IS ALREADY CALCULATED AT OFSIM5 AS
C     ANSG2S(I), STORED IN COMMON AREA.
      XLP2 =  DS2DX*CP2(ITK)
      FL2(ITK) =-XLP2*COBET2
      FD2(ITK) =  XLP2*SIBET2
  338 CONTINUE
      SPACE = CSPACE
      CLIFT = 0.5*CSPACE*FL(2)+0.5*FSPACE*FL(LPM1)
      CDRAG = 0.5*CSPACE*FD(2)+0.5*FSPACE*FD(LPM1)
      DO 111 IUA = 2,LPM3,2
      IF(IUA.GE.LPK) SPACE = FSPACE
      CLIFT = CLIFT+SPACE*(FL(IUA)+4.*FL(IUA+1)+FL(IUA+2))/3.
  111 CDRAG = CDRAG+SPACE*(FD(IUA)+4.*FD(IUA+1)+FD(IUA+2))/3.
      DO 321 IUA = 1,NS2A,2
      CLIFT = CLIFT+GAP2*(FL2(IUA)+4.*FL2(IUA+1)+FL2(IUA+2))/3.
  321 CDRAG = CDRAG+GAP2*(FD2(IUA)+4.*FD2(IUA+1)+FD2(IUA+2))/3.
```

```
C-----ADD THE FORCES ON CAVITY PORTIONS.
C      SUBROUTINE XCYC CALCULATES
C    THE POINT ON THE UPPER BLADE PORTION CORRESP. TO THE CAVITY END POINT.
       CXA=XCCC
       CYA=YCCC
       CALL XCYC(XCCCB,YCCCB,CXA,CYA)
       CLIFT = CLIFT+SIGMA*XCCCB
       CDRAG = CDRAG-SIGMA*YCCCB
C-----XCCC AND YCCC ARE THE END POINTS OF CAVITY, CALCULATED IN
C      SUBROUTINE CAVITY
C      STORED IN COMMON.
C                                                                              *
C                                                                              *
C**********MAIN INSERT 3 ************************************************
C
C
C FIND BINF IN Z-1.
       U2U1=COS(ALFA1+GAMMA)/COS(SXSI(5)+GAMMA)
       DOWN=COS(ALFA1+GAMMA)*COS(SXSI(5)+GAMMA)
       BINF=0.5*SIN(ALFA1+SXSI(5)+2.*GAMMA)/DOWN
       BINF=ATAN(1./BINF)
       AINF=0.5*PAI-BINF-GAMMA
C CDSTAR AND CLSTAR ARE BASED ON VELOCITY AT UPSTREAM INFINITY IN (X,Y).
       CDSTAR=CDRAG
       CLSTAR=CLIFT
       UINF=0.5*SQRT(1.+U2U1**2+2.*U2U1*COS(ALFA1-SXSI(5)))
       FINF=2.*DRAG*SIN(ALFA1-SXSI(5))/(UINF*COS(SXSI(5)+GAMMA))
       CLINF=CLSTAR*COS(AINF)-CDSTAR*SIN(AINF)
       CDINF=CLSTAR*SIN(AINF)+CDSTAR*COS(AINF)
       CLINF=CLINF/UINF**2
       CDINF=CDINF/UINF**2
       WRITE(6,117) CLINF,CDINF
  117 FORMAT(1X,34HCLINF OR CDINF=FORCE/1/2RO.UINF**2,5X,6HCLINF=,E14.7,
      X1X,6HCDINF=,E14.7)
       WRITE(6,118) FINF
  118 FORMAT(1X,34HFINF IS OBTAINED FROM MOMENTUM EQN,5HFINF=,E14.7)
       WRITE(6,221)
  221 FORMAT(1X,48H---CCLL & CCDD ARE BASED ON U1 IN ALFA1 DIRE.---)
       CCLL=CLSTAR*COS(ALFA1)-CDSTAR*SIN(ALFA1)
       CCDD=CLSTAR*SIN(ALFA1)+CDSTAR*COS(ALFA1)
       ALOD=CCLL/CCDD
       WRITE(6,181) CCDD,CCLL,ALOD
  181 FORMAT(1X,5HCCDD=,E14.7,1X,5HCCLL=,E14.7,1X,4HL/D=,E14.7)
       MSTOP1=MSTOP-1
       IF(ITERA.LE.MSTOP1) GO TO 140
C
C
C**********MAIN INSERT 4 ************************************************
C                                                                              *
C                                                                              *
C      CAVITY SHAPE.
C         ALREADY CALCULATED IN
C         SUBROUTINE CAVITY.
       WRITE(6,287)
  287 FORMAT(2X,*---CAVITY SHAPE------*)
       NCAV1=NCAV+1
       DO 285 KCAV=1,NCAV1,2
  285 WRITE(6,286) CAVX(KCAV ),CAVY(KCAV )
  286 FORMAT(10X,*X=*,E14.7,10X,*Y=*,E14.7)
C                                                                              *
```

```
C                                                                       *
C**********MAIN INSERT 4 ***************************************************
C
C
  140 CONTINUE
      XCCC=0.
      YCCC=0.
      WRITE(6,823)
  823 FORMAT(///,'----------UPPER BODY SHAPE----------')
      DO 821 ISHP=1,51
      X=.02*(ISHP-1)
      CALL SHAPE      (X,Y,BETA,1)
  821 WRITE(6,822) X,Y
  822 FORMAT(5X,'X=',F10.5,2X,'Y=',F10.5)
      REWIND 7
      WRITE(7,763) SXSI(1),SXSI(2),SXSI(3),SXSI(4),SXSI(5)
  763 FORMAT(5E14.7)
      DO 766 IC=1,LPM
  766 WRITE(7,767) SARC(IC),BETAN(IC)
  767 FORMAT(2E14.7)
      DO 1766 IC=1,LPMM1
 1766 WRITE(7,767) SARC2(IC),BETAN2(IC)
      IF(ITERA.GE.MSTOP) GO TO 999
      LPK1=LPK-1
      SPACE=CSPACE
      HSPACE=HCSPAC
      DO 50 IM=1,LPM1
      IF(IM.EQ.1) GO TO 51
      IF(IM.EQ.LPM1) GO TO 55
      IF(IM.EQ.LPK1) GO TO 97
      IF(IM.EQ.LPK) GO TO 98
      IF(IM.GT.LPK) GO TO 93
      XY=-1.+SPACE*FLOAT(IM-1)+HSPACE
      XZ(1)=-1.+SPACE*FLOAT(IM-2)
      XZ(2)=XZ(1)+SPACE
      XZ(3)=XZ(2)+SPACE
      XZ(4)=XZ(3)+SPACE
      GO TO 99
   93 SPACE=FSPACE
      HSPACE=HFSPAC
      XY=XBET+HSPACE+ SPACE*FLOAT(IM-LPK)
      XZ(1)=XBET+SPACE*FLOAT(IM-LPK-1)
      XZ(2)=XZ(1)+SPACE
      XZ(3)=XZ(2)+SPACE
      XZ(4)=XZ(3)+SPACE
   99 DO 56 IK=1,4
   56 YBE(IK)=BETAN(IM+IK-2)
      BETAM(IM)=AITKEN(XZ,YBE,XY,3)
      GO TO 151
   97 BETAM(LPK1)=0.5*(BETAN(LPK1)+BETAN(LPK))
      GO TO 151
   98 BETAM(LPK)=0.5*(BETAN(LPK)+BETAN(LPK+1))
      GO TO 151
   51 BETAM(1)=0.5*(BETAN(1)+BETAN(2))
      GO TO 151
   55 BETAM(LPM1)=0.5*(BETAN(LPM1)+BETAN(LPM))
  151 CONTINUE
   50 CONTINUE
      IF(ITERA.EQ.1) GO TO 6
      DO 41 IE=1,LPM
```

```
   41 BETAN(IE)=BETAN(IE)*(1.-XXM)+BETAN0(IE)*XXM
      DO 42 IFG=1,LPM1
   42 BETAM(IFG)=BETAM(IFG)*(1.-XXM)+BETA10(IFG)*XXM
      DO 425 IFG=1,LPMM1
  425  BETAN2(IFG) = BETAN2(IFG)*(1.-XXM)+BETA02(IFG)*XXM
      DO 852 IRP=1,5
  852 SXSI(IRP)=SXSI(IRP)*(1.-XXM)+SXSI0(IRP)*XXM
    6 ITERA=ITERA+1
      IF(ITERA.GT.MSTOP) GO TO 28
      GO TO 160
   28 WRITE(6,29)
   29 FORMAT(5X,26HITERATION WAS TERMAINATED.)
  999 CONTINUE
      STOP
      END

      SUBROUTINE DXFNEW(X,STOL,M,I,DG,DF,FFF4)
      DIMENSION F(5),P(50,5),X(5),D(5,5),XRRI(5),XMMI(5)
      COMMON/DELTAD/DELT(5,5)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),AMSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON SIGMA,SBETA,XXM,ICPI,SARC00(513)
      COMMON IDGL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(5),CCC1,CLE,ERC,YYY,XM,ITERA,SXSI0(5),SXSI00(5),YXS(5)
      COMMON PSIZ,LP,SARC(513),SARC0(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
      PAI=3.141592653
      I=0
      IF(ITERA.LE.3) GO TO 272
      DO 67 IIJ=1,5
   67 WRITE(6,66) IIJ,X(IIJ)
   66 FORMAT(1X,2HX(,I1,2H)=,E14.7)
  272 CONTINUE
   55 SI1=2.*DE
      SI6=2.*DG
      IF(X(1).LT.SI1) X(1)=SI1
      SI10=X(1)+2.*DG
      IF(X(2).LT.SI10) X(2)=SI10
      SI11=X(2)+2.*DG
      IF(X(3).LT.SI11) X(3)=SI11
      IF(X(4).LT.SI6) X(4)=SI6
      SI5=(0.5*PAI-GAMMA)*(1.-0.02)
      IF(X(5).LT.0.) GO TO 76
      IF(X(5).GT.SI5) X(5)=SI5
      GO TO 79
   76 IF(ABS(X(5)).GT.SI5) X(5)=-SI5
   79 CONTINUE
      DO 68 IIJ=1,5
   68 WRITE(6,65) IIJ,X(IIJ)
      IJ=1
C-----F(1)-------------------------------------------------------------
      DO 20 IK=1,5
   20 YXS(IK)=X(IK)
    5 CONTINUE
      KCIRL = 1
```

```
      CALL F1INTL(YINT1,KCTRL)
C     SUBROUTINE F1INTL CALCULATES THE INTEGRALS IN F(1).
      KCTRL = 2
      CALL F1INTL (YINT2,KCTRL)
      KCTRL = 3
      CALL F1INTL (YINT3,KCTRL)
      KCTRL = 4
      CALL F1INTL (YINT4,KCTRL)
      CS1 = ALOG(COS(YXS(5)+GAMMA)/COS(ALFA1+GAMMA))
      IF(IJ.EQ.1) WRITE(6,423) YINT4
  423 FORMAT(1X,'YINT4=',F20.10)
      FA = -(YINT1/PAI+YINT2-(CCC1+CS1/PAI)*YINT3
     1+YINT4/PAI-YXS(5))
      IF (IJ.EQ.1) F(1) = FA
      IF (IJ.EQ.2) GO TO 3
      IF (IJ.EQ.3) GO TO 4
      IF (IJ.EQ.4) GO TO 320
      IF (IJ.EQ.5) GO TO 321
      IF (IJ.EQ.6) GO TO 322
      IF(IJ.EQ.66) GO TO 3222
      F(1,5) = TAN(YXS(5)+GAMMA)*YINT3/PAI-1.
      IJ = 2
      YXS(1) = X(1)+DELT(1,1)
      GO TO 5
    3 F1P = -FA
      IJ = 3
      YXS(1) = X(1)-DELT(1,1)
      GO TO 5
    4 F1G = -FA
      F(1,1) = (F1P-F1G)/(2.*DELT(1,1))
      IJ = 4
      YXS(1) = X(1)
      YXS(2) = X(2)+DELT(1,2)
      GO TO 5
  320 F1P = -FA
      YXS(2) = X(2)-DELT(1,2)
      IJ = 5
      GO TO 5
  321 F1G = -FA
      F(1,2) = (F1P-F1G)/(2.*DELT(1,2))
      YXS(2) = X(2)
      YXS(3) = X(3)+DELT(1,3)
      IJ = 6
      GO TO 5
  322 F1P = -FA
      IJ=66
      YXS(3)=X(3)-DELT(1,3)
      GO TO 5
 3222 F1G=-FA
      F(1,3) = (F1P-F1G)/(2.*DELT(1,3))
      F(1,4) = 0.
C-----F(2) AND F(3)-------------------------------------------------------
      IJ=7
      DO 30 IM=1,5
   30 YXS(IM)=X(IM)
      IJ = 7
  330 CONTINUE
      XKKK = ALOG(COS(ALFA1+GAMMA)/COS(YXS(5)+GAMMA))
      XX1  = YXS(4)+SIN(DELTA)
      YY1  = YXS(4)+COS(DELTA)
```

```
      YY12=YY1**2
      CON1 = CCC1-XKKX/PAI
      XRR = 0.
      XMM = 0.
      DO 331 MIQ = 1,4
      CALL XMINT(SOLNR,SOLNM,MIQ)
      XRRI(MIQ) = SOLNR
      XMMI (MIQ) = SOLNM
      XRRR = -XRRI(MIQ)/PAI
      XMMM = -XMMI(MIQ)/PAI
      IF (MIQ.EQ.1) XRRR = CON1+XRRI(MIQ)
      IF (MIQ.EQ.1) XMMM = CON1+XMMI(MIQ)
      IF (MIQ.EQ.4) XRRR = -XRRI(MIQ)
      IF (MIQ.EQ.4) XMMM = -XMMI(MIQ)
      IF(MIQ.EQ.3.AND.IJ.EQ.7) WRITE(6,425) SOLNR,SOLNM
  425 FORMAT(1X,*SOLNR=*,F20.10,2X,*SOLNM=*,F20.10)
      XRR = XRR+XRRR
      XMM = XMM+XMMM
  331 CONTINUE
C-----CALCULATION OF H1(ZETA1)-------.
      XSIP1 = XX1+1.
      XSIMB = XX1-YXS(1)
      XSIMF = XX1-YXS(3)
      XSIMC = XX1-YXS(2)
      XSIP12 = XSIP1**2
      XSIMB2 = XSIMB**2
      XSIMF2 = XSIMF**2
      XSIMC2 = XSIMC**2
      RRA = SQRT(XSIP12+YY12)
      RRB = SQRT(XSIMB2+YY12)
      RRC = SQRT(XSIMF2+YY12)
      RRD = SQRT(XSIMC2+YY12)
      THIA = ATAN(YY1/XSIP1)
      IF (XSIP1.LE.0.) THIA = PAI+THIA
      THIB = ATAN(YY1/XSIMB)
      IF (XSIMB.LE.0.) THIB = PAI+THIB
      THIC = ATAN(YY1/XSIMF)
      IF (XSIMF.LE.0.) THIC = PAI+THIC
      THID = ATAN(YY1/XSIMC)
      IF (XSIMC.LE.0.) THID = PAI+THID
      RR1 = SQRT(RRA*RRB*RRC/RRD)
      THIT1 = .5*(THIA+THIB+THIC-THID)
      COTH1 = COS(THIT1)
      SITH1 = SIN(THIT1)
      F2CO = RR1*(XRR*COTH1-XMM*SITH1)-ALFA1
      F3CO = RR1*(XRR*SITH1+XMM*COTH1)+YKKX
      IF (IJ.EQ.7) F(2) = -F2CO
      IF (IJ.EQ.7) F(3) = -F3CO
      IF (IJ.EQ.8) GO TO 340
      IF (IJ.EQ.9) GO TO 341
      IF (IJ.EQ.10) GO TO 342
      IF (IJ.EQ.11) GO TO 343
      IF (IJ.EQ.12) GO TO 344
      IF (IJ.EQ.13) GO TO 345
      IF (IJ.EQ.14) GO TO 346
      IF (IJ.EQ.15) GO TO 347
      TA2G =  TAN(YXS(5)+GAMMA)
      P(2,5) = -RR1*TA2G*(XRRI(1)*COTH1-XMMI(1)*SITH1)
      P(2,5) = P(2,5)/PAI
      P(3,5) = -RR1*TA2G*(XRRI(1)*SITH1+XMMI(1)*COTH1)
```

```
      P(3,5) = P(3,5)/PAI*TA2G
      IJ = 8
      YXS(1) = X(1)+DELT(1,2)
      GO TO 330
  340 FP2 = F2CO
      FP3 = F3CO
      IJ = 9
      YXS(1) = X(1)-DELT(2,1)
      GO TO 330
  341 P(2,1) = (FP2-F2CO)/(2.*DELT(2,1))
      P(3,1) = (FP3-F3CO)/(2.*DELT(2,1))
      YXS(1) = X(1)
      YXS(2) = X(2)+DELT(2,2)
      IJ = 10
      GO TO 330
  342 FP2 = F2CO
      FP3 = F3CO
      YXS(2) = X(2)-DELT(2,2)
      IJ=11
      GO TO 330
  343 P(2,2) = (FP2-F2CO)/(2.*DELT(2,2))
      P(3,2) = (FP3-F3CO)/(2.*DELT(2,2))
      YXS(2) = X(2)
      YXS(3) =   X(3)+DELT(2,3)
      IJ = 12
      GO TO 330
  344 FP2 = F2CO
      FP3 = F3CO
      YXS(3) = X(3)-DELT(2,3)
      IJ = 13
      GO TO 330
  345 P(2,3) = (FP2-F2CO)/(2.*DELT(2,3))
      P(3,3) = (FP3-F3CO)/(2.*DELT(2,3))
      YXS(4) = X(4)+DELT(2,4)
      YXS(3)=X(3)
      IJ=14
      GO TO 330
  346 FP2=F2CO
      FP3=F3CO
      YXS(4) = X(4)-DELT(2,4)
      IJ = 15
      GO TO 330
  347 P(2,4) = (FP2-F2CO)/(2.*DELT(2,4))
      P(3,4) = (FP3-F3CO)/(2.*DELT(2,4))
      YXS(4)=X(4)
C------F(4)-----------------------------------------------------------------
      IJ=16
      YXS(1)=X(1)+DELT(4,1)
  199 CALL OFSIN2(ANS2)
      IF(IJ.EQ.15) GO TO 675
      IF(IJ.EQ.16) GO TO 613
      IF(IJ.EQ.17) GO TO 614
      IF(IJ.EQ.19) GO TO 615
      IF(IJ.EQ.20) GO TO 616
      IF(IJ.EQ.21) GO TO 617
      IF(IJ.EQ.22) GO TO 618
      IF(IJ.EQ.23) GO TO 621
      IF(IJ.EQ.24) GO TO 622
      IF(IJ.EQ.25) GO TO 623
      IF(IJ.EQ.26) GO TO 624
```

```
  613 ANSP=ANS2
      IJ=17
      YXS(1)=X(1)-DELT(4,1)
      GO TO 199
  614 ANSQ=ANS2
      IJ=18
      P(4,1)=-(ANSP-ANSQ)/(2.*DELT(4,1))
      YXS(1)=X(1)
      GO TO 199
  675 ANSF=ANS2
      F(4)=-(BIGS-ANSF)
      IJ=19
      YXS(2)=X(2)+DELT(4,2)*ABS(X(2))
      GO TO 199
  615 ANSPP=ANS2
      IJ=20
      YXS(2)=X(2)-DELT(4,2)*ABS(X(2))
      GO TO 199
  616 ANSQQ=ANS2
      P(4,2)=-(ANSPP-ANSQQ)/(2.*DELT(4,2)*ABS(X(2)))
      YXS(2)=X(2)
      IJ=21
      YXS(3)=X(3)+DELT(4,3)*X(3)
      GO TO 199
  617 ANS1P=ANS2
      IJ=22
      YXS(3)=X(3)-DELT(4,3)*X(3)
      GO TO 199
  618 ANS1Q=ANS2
      P(4,3)=-(ANS1P-ANS1Q)/(2.*DELT(4,3)*X(3))
      YXS(3)=X(3)
      IJ=23
      YXS(4)=X(4)+DELT(4,4)*ABS(X(4))
      GO TO 199
  621 ANA=ANS2
      IJ=24
      YXS(4)=X(4)-DELT(4,4)*ABS(X(4))
      GO TO 199
  622 ANB=ANS2
      P(4,4)=-(ANA-ANB)/(2.*DELT(4,4)*ABS(X(4)))
      YXS(4)=X(4)
      IJ=25
      YXS(5)=X(5)+DELT(4,5)
      GO TO 199
  623 BNA=ANS2
      IJ=26
      YXS(5)=X(5)-DELT(4,5)
      GO TO 199
  624 BNB=ANS2
      P(4,5)=-(BNA-BNB)/(2.*DELT(4,5))
      YXS(5)=X(5)
      FFF4=F(4)
      YXS(5) = X(5)
C F(5).
C   FIRST CALCULATE THE PHYSICAL COORDINATES
C  FOR THE END POINT OF CAVITY.
C   THIS SUBROUTINE FINDS THE END POINT OF VACITY.
      IJ = 27
  815 CALL CAVITY (XCEND,YCEND)
C  THEN FIND S2- THE ARC LENGTH OF THE SECOND WETTED PORTION.
```

```
C  CALL SUBROUTINE ARCS2 FOR THIS PURPOSE.
      CALL ARCS2 (S2,XCEND,YCEND)
      IF(IJ.EQ.27) BIGS2=S2
C  FINALLY GO INTO F(5) COMPUTATIONS.
      CALL OFSIM5(ANS5)
      IF(IJ.EQ.27) GO TO 820
      IF(IJ.EQ.28) GO TO 821
      IF (IJ.EQ.29) GO TO 822
      IF (IJ.EQ.30) GO TO 823
      IF (IJ.EQ.31) GO TO 824
      IF (IJ.EQ.32) GO TO 825
      IF (IJ.EQ.33) GO TO 826
      IF (IJ.EQ.34) GO TO 827
      IF(IJ.EQ.341) GO TO 830
      IF (IJ.EQ.35) GO TO 828
      IF (IJ.EQ.36) GO TO 829
  820 F(5) = -(S2-ANS5)
      IJ = 28
      YXS(1) = X(1)+DELT(5,1)
      GO TO 815
  821 ANP = ANS5-S2
      IJ = 29
      YXS(1) = X(1)-DELT(5,1)
      GO TO 815
  822 P(5,1) = -(ANP-(ANS5-S2))/(2.*DELT(5,1))
      YXS(1) = X(1)
      YXS(2) = X(2)+DELT(5,2)*ABS(X(2))
      IJ = 30
      GO TO 815
  823 ANP = ANS5-S2
      YXS(2) = X(2)-DELT(5,2)*ABS(X(2))
      IJ = 31
      GO TO 815
  824 P(5,2) = -(ANP-(ANS5-S2))/(2.*DELT(5,2)*ABS(X(2)))
      YXS(2) = X(2)
      IJ = 32
      YXS(3) = X(3)+DELT(5,3)*X(3)
      GO TO 815
  825 ANP = ANS5-S2
      YXS(3) = X(3)-DELT(5,3)*X(3)
      IJ = 33
      GO TO 815
  826 P(5,3) = -(ANP-(ANS5-S2))/(2.*DELT(5,3)*X(3))
      IJ = 34
      YXS(3) = X(3)
      YXS(4) = X(4)+DELT(5,4)*ABS(X(4))
      GO TO 815
  827 ANP = ANS5-S2
      YXS(4) = X(4)-DELT(5,4)*ABS(X(4))
      IJ=341
      GO TO 815
  830 CONTINUE
      P(5,4) = -(ANP-(ANS5-S2))/(2.*DELT(5,4)*ABS(X(4)))
      YXS(4) = X(4)
      YXS(5) = X(5)+DELT(5,5)
      IJ = 35
      GO TO 815
  828 ANP = ANS5-S2
      YXS(5) = X(5)-DELT(5,5)
      IJ =36
```

```
      GO TO 815
  829 P(5,5) = -(ANP-(ANSS-S2))/(2.*DELT(5,5))
      DO 666 IK=1,5
  666 WRITE(6,667)(P(IK,J),J=1,5)
  667 FORMAT(3X,*P(I,J)=*,5(E14.7,2X))
      WRITE(6,251) BIGS2,XCCC,YCCC
  251 FORMAT(20X,*BIGS2=*,F10.5,2X,*XCCC=*,F10.5,2X,*YCCC=*,F10.5)
      NCAV1=NCAV+1
      DO 253 ICV=1,NCAV1,2
  253 WRITE(6,252) CAVX(ICV),CAVY(ICV)
  252 FORMAT(10X,*CAVX=*,F10.5,5X,*CAVY=*,F10.5)
      DO 129 ITX=1,5
  129 WRITE(6,131) ITX,F(ITX)
  131 FORMAT(1X,2HF(,I1,2H)=,E14.7)
      DO 132 IUP=1,5
      IF(ITERA.LE.3) GO TO 385
      DO 132 IUQ=1,5
  132 WRITE(6,133) IUP,IUQ,P(IUP,IUQ)
  133 FORMAT(1X,2HP(,I1,1H,,I1,2H)=,E14.7)
  385 CONTINUE
      CALL DETERM(P,5,DETBO)
      DO 25 IDET=1,5
      DO 26 LPG=1,5
      Q(LPG,IDET)=P(LPG,IDET)
   26 P(LPG,IDET)=F(LPG)
      CALL DETERM(P,5,DETE)
      IF(IDET.EQ.1) DELB=DETE/DETBO
      IF(IDET.EQ.2) DELC=DETE/DETBO
      IF(IDET.EQ.3) DELD=DETE/DETBO
      IF(IDET.EQ.4) DELE=DETE/DETBO
      IF(IDET.EQ.5) DELF=DETE/DETBO
      DO 27 LPG=1,5
   27 P(LPG,IDET)=Q(LPG,IDET)
   25 CONTINUE
      X(1)=X(1)+DELB
      X(2)=X(2)+DELC
      X(3)=X(3)+DELD
      X(4)=X(4)+DELE
      X(5)=X(5)+DELF
      DO 60 LMN=1,5
   60 WRITE(6,61) LMN,X(LMN)
   61 FORMAT(1X,2HX(,I1,2H)=,E14.7)
      ABSB=ABS(DELB/X(1))
      ABSC=ABS(DELC/X(2))
      ABSD=ABS(DELD/X(3))
      ABSE=ABS(DELE/X(4))
      ABSF=ABS(DELF/X(5))
      KEID=0
      IF(ABSB.LT.STOL) KEID=1
      IF(ABSC.GT.STOL) KEID=0
      IF(ABSD.GT.STOL) KEID=0
      IF(ABSE.GT.STOL) KEID=0
      IF(ABSF.GT.STOL) KEID=0
      IF(KEID.EQ.1) GO TO 35
      I=I+1
      WRITE(6,42) I
   42 FORMAT(20X,14HITERATION NO.=,I2)
      IF(I.EQ.M) GO TO 35
      GO TO 55
   35 IF(I.EQ.M) GO TO 36
```

```
      SUBROUTINE OFSIM1(ANS,NOF,XCA)
      DIMENSION XST(5)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON SIGMA,SBETA,XXM,ICPI,SARCOO(513)
      COMMON IOUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(5),CCC1,CLE,ERC,YYY,XM,ITERA,SXSID(5),SXSIDD(5),YXS(5)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XOX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
C     NOF    = 0  CALLED FROM FIINT.
C     NOF    = 1  CALLED FROM RMINT FOR REAL PART.
C     NOF    = 2  CALLED FROM RMINT FOR IMAG. PART.
C     NOF    = 3  CALLED FROM CAVITY OXFNEW AT F(5)
      IF (ICPI.EQ.0) GO TO 9
      DO 10 IQ = 1,5
   10 XST(IQ) = XSN(IQ)
      GO TO 12
    9 DO 11 IH = 1,5
   11 XST(IH) = YXS(IH)
   12 CONTINUE
      IF(ITERA.EQ.1) GO TO 222
      GO TO 223
  222 DO 224 ILK = 1,LPM
  224 BETAN(ILK) = SBETA
  223 CONTINUE
      CSPACE = (1.+XST(1))/FLOAT(LPK)
      FSPACE = CSPACE/FLOAT(LPM-LPK)
      LPM3=LPM-3
      XBET = -1.+CSPACE*FLOAT(LPK-1)
      XSI1=-1.+CSPACE
      BE1 = BETAN(2)
      AP1 = (XSI1-XST(2))/((XSI1+1.)*(XST(1)-XSI1)*(XSI1-XST(3)))
      AP1S = SQRT(AP1)
      F3 = BE1*AP1S
      XX1 = XST(4)*SIN(DELTA)
      YY1 = XST(4)*COS(DELTA)
      YY12 = YY1**2
      PLM = XSI1 -XX1
      PLM2 = PLM**2
      PLMA = PLM2+YY12
      PXSR = PLM/PLMA
      PXSI = YY1/PLMA
      IF(NOF.EQ.1) F3 = F3*PXSR
      IF(NOF.EQ.2) F3 = F3*PXSI
      IF(NOF.EQ.3) F3=F3/(XSI1-XCA)
      ANSA=0.
      DO 1 I = 2,LPM3,2
      F1 = F3
      SPACE = CSPACE
      IF (I.GE.LPK) GO TO 30
      XSI2 = -1.+SPACE*FLOAT(I)
      XSI3 = XSI2+SPACE
      GO TO 31
   30 SPACE  = FSPACE
      XSI2 = XBET+SPACE*FLOAT(I-LPK+1)
```

```
      GO TO 38
   36 WRITE(6,37)
   37 FORMAT(1X,34HOXFNEW DID NOT CONVERGE WITHIN 99)
      IF(X(1).LT.SI1) X(1)=SI1
      SI10=X(1)+2.*DG
      IF(X(2).LT.SI10) X(2)=SI10
      SI11=X(2)+2.*DG
      IF(X(3).LT.SI11) X(3)=SI11
      IF(X(4).LT.SI6) X(4)=SI6
      SI5=(0.5*PAI-GAMMA)*(1.-0.02)
      IF(X(5).LT.0.) GO TO 91
      IF(X(5).GT.SI5) X(5)=SI5
      GO TO 82
   91 IF(ABS(X(5)).GT.SI5) X(5)=-SI5
   82 CONTINUE
   38 RETURN
      END
vv
```

```
      XSI3 = XSI2+SPACE
   31 BE2 = BETAN(I+1)
      BE3 = BETAN(I+2)
      AP2 = (XSI2-XST(2))/((XSI2+1.)*(XST(1)-XSI2)*(XSI2-XST(3)))
      AP3 = (XSI3-XST(2))/((XSI3+1.)*(XST(1)-XSI3)*(XSI3-XST(3)))
      AP2S = SQRT(AP2)
      AP3S = SQRT(AP3)
      F2 = BE2*AP2S
      F3 = BE3*AP3S
      HA2 = XSI2-XX1
      HA22 = HA2**2
      HB = HA22+YY12
      HCR2 = HA2/HB
      HCI2 = YY1/HB
      HA3 = XSI3-XX1
      HA32 = HA3**2
      HD=HA32+YY12
      HCR3 = HA3/HD
      HCI3 = YY1/HD
      IF(NOF.EQ.1) F2 = F2*HCR2
      IF(NOF.EQ.1)  F3 = F3*HCR3
      IF (NOF.EQ.2)  F2 = F2*HCI2
      IF(NOF.EQ.2)  F3 = F3*HCI3
      IF (NOF.EQ.3)  F2 = F2/(XSI2-XCA)
      IF(NOF.EQ.3)  F3 = F3/(XSI3-XCA)
      FSUM = (F1+4.*F2+F3)*SPACE/3.
      ANSA = ANSA+FSUM
    1 CONTINUE
      SQ1 = SQRT((-1.-XST(2))/(-1.-XST(3)))
      SQ2 = SQRT(XST(1)+1.)
      SQ3 = SQRT((XST(1)-XST(2))/(XST(1)-XST(3)))
      ANT1 = BETAN(1)*2.*SQRT(CSPACE)*SQ1/SQ2
      ANT2 = BETAN(LPM)*2.*SQRT(FSPACE)*SQ3/SQ2
      APLA = -1.-XX1
      APLA2 = APLA**2
      APLB = XST(1)-XX1
      APLB2 = APLB**2
      IF(NOF.EQ.1) ANT1 = ANT1*APLA/(APLA2+YY12)
      IF (NOF.EQ.1) ANT2 = ANT2*APLB/(APLB2+YY12)
      IF (NOF.EQ.2 ) ANT1 = ANT1*YY1/(APLA2+YY12)
      IF (NOF.EQ.2) ANT2 = ANT2*YY1/(APLB2+YY12)
      IF (NOF.EQ.3) ANT1 = ANT1/(-1.-XCA)
      IF (NOF.EQ.3) ANT2 = ANT2/(XST(1)-XCA)
      ANS  = ANSA+ANT1+ANT2
      RETURN
      END
      SUBROUTINE OFSIM2(ANS2)
      DIMENSION X(3),XIT(3),YY(3),XITC(3),EXU(3),FCN3(3),XST(5)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON SIGMA,SBETA,XXM,ICPI,SARC00(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(5),CCC1,CLE,ERC,YYY,XM,ITERA,SXSIO(5),SXSI00(5),YXS(5)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XOX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
```

```
      DO 13 I6=1,5
   13 XST(I6)=YXS(I6)
      PAI=3.141592653
      UU2=COS(ALFA1+GAMMA)/COS(XST(5)+GAMMA)
      XXX(=ALOG(UU2)
      CSPACE=(1.+ XST(1))/FLOAT(LPK)
      HCSPAC=0.5*CSPACE
      FSPACE=CSPACE/FLOAT(LPM-LPK)
      HFSPAC=0.5*FSPACE
      XBET=-1.+CSPACE*FLOAT(LPK-1)
      CDE=COS(DELTA)
      SDE=SIN(DELTA)
      GA=XST(1)-XST(4)*SDE
      GB=XST(4)*CDE
      PPP=CDE/(GA**2+GB**2)
      FCN3(3)=DGAP*PPP*XST(1)/(PAI*SQRT(1.+SIGMA))
      LPKI=LPM-LPK+1
      DO 1 IP=1,LPM
      IF(IP.EQ.1) GO TO 2
      HSPACE=HFSPAC
      SPACE=FSPACE
      IF(IP.GT.LPK1) GO TO 30
      X(1)=XST(1)-SPACE*FLOAT(IP-2)
      X(2)=X(1)-HSPACE
      X(3)=X(1)-SPACE
      GO TO 31
   30 HSPACE=HCSPAC
      SPACE=CSPACE
      X(1)=XBET-SPACE*FLOAT(IP-LPK(I-1)
      X(2)=X(1)-HSPACE
      X(3)=X(1)-SPACE
   31 FCN3(1)=FCN3(3)
      NK=3
      IF(IP.EQ.LPM) NK=2
      DO 8 I=2,NK
      IF(IJ.GE.23) GO TO 3
      GO TO 7
    3 IF(I.EQ.2) XIT(2)=XITM(LPM-IP+1)
      IF(I.EQ.3) XIT(3)=XITN(LPM-IP+1)
      GO TO 5
    7 CONTINUE
      YY(I)=X(I)
C OFSIM3 CALCULATE G1 .
      CALL OFSIM3(YY(I),XITC(I),IP,I)
      XIT(1)=XITC(I)
      IF(IJ.EQ.15) GO TO 6
      GO TO 5
    6 IF(I.EQ.2) XITM(LPM-IP+1)=XIT(I)
      IF(I.EQ.3) XITN(LPM-IP+1)=XIT(I)
    5 CONTINUE
      EXU(I)=EXP(-XIT(I))
      GC=X(I)-XST(4)*SDE
      GD=XST(4)*CDE
      PXA=GC**2+GD**2
      DWDX=DGAP*X(I)*CDE/(PXA*PAI)
      FCN3(I)=EXU(I)*DWDX/UU2
      IF(X(I).LE.0.) FCN3(I)=-FCN3(I)
    8 CONTINUE
C CHECK IF FCN3(I) IS ALWAYS POSITIVE.
      IF(IP.EQ.LPM) GO TO 20
```

```
      GO TO 21
   20 PPQ=CDE/((-1.-XST(4)*SDE)**2+(XST(4)*CDE)**2)
      FF3=DGAP*PPQ/PAI
      FCN3(3)=FF3
   21 SUM=(FCN3(1)+FCN3(2)*4.+FCN3(3))*HSPACE/3.
      ANS2=ANS2+SUM
      IF(IJ.EQ.19) SARC(LPM-IP+1)=ANS2
      GO TO 1
    2 SARC(LPM)=0.
      ANS2=0.
    1 CONTINUE
C XITN(LPM)=G1 AT POINT 6.
C XINT(1)=G1 AT POINT X=1.
      XITN(LPM)=CCC1-XXXX/PAI
      XITN(1)=0.
      RETURN
      END

      SUBROUTINE DFSIM3(Y,XXII,IP,I)
      DIMENSION XST(5),FXLS(100),FA(200)
      COMMON YCCC,SBETA2
      COMMON XITN(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETA8,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFAI,GAMMA
      COMMON SIGMA,SBETA,XXM,ICPI,SARCOD(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(5),CCC1,CLE,ERC,YYY,XM,ITERA,SXSIO(5),SXSIOO(5),YXS(5)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XOX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,IGAUS(100),WGAUS(100),NGAUS
C     FOUR INTEGRALS TO BE EVALUATED BEFORE XI IS OBTAINED.
C     NOTE THAT PRIVIOUSLY ONLY ONE  SINGULAR INTEGRAL WAS
C     CALCULATED IN GCASCAD AND CASCADE.
C     SEE THE NOTE OF TC 3951 FOR FOUR INTEGRALS, OUT OF WHICH
C     TWO ARE OF SINGULAR TYPE.
      IF(ICPI.EQ.0) GO TO 9
      DO 11 ISI=1,5
   11 XST(ISI)=XSN(ISI)
      GO TO 12
    9 DO 13 JTJ=1,5
   13 XST(JTJ)=YXS(JTJ)
   12 PAI=3.141592653
C-----FIRS  I1-------
      IF (ITERA.EQ.1) GO TO 60
      GO TO 61
   60 CONTINUE
      DO 62 IZU = 1,LPM
      BETAN(IZU) = SBETA
      BETAM(IZU) = SBETA
   62 CONTINUE
   61 CONTINUE
      CSPACE=(1.+ XST(1))/FLOAT(LPK)
      HCSPAC=0.5*CSPACE
      FSPACE=CSPACE/FLOAT(LPM-LPK)
      HFSPAC=0.5*FSPACE
      XBET=-1.+CSPACE*FLOAT(LPK-1)
      AB2=SQRT(XST(1)+1.)
      AB3=SQRT((1.+Y)*(XST(1)-Y))
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```
      AB6 = SQRT((XST(3)-Y)/(XST(2)-Y))
      AB3 = AB3*AB6
      IU2=LPM-IP+1
      IU3=1
      IF(I.EQ.3) IU3=LPM-IP+1
      IF(I.EQ.0) IU3=IP
      BEC=BETAN(IU3)
      IF(I.EQ.2) BEC=BETAM(IU2)
      FAA=BEC/AB3
      LPM1=LPM-1
      DO 1 IW=2,LPM1
      SPACE=CSPACE
      IF(IW.GT.LPK) GO TO 45
      XSK=-1.+SPACE*FLOAT(IW-1)
      GO TO 46
   45 SPACE=FSPACE
      XSK=XBET+ SPACE*FLOAT(IW-LPK)
   46 IF(I.EQ.2) GO TO 6
      IF(IW.EQ.IU3) GO TO 1
    6 FS=SQRT((1.+XSK)*(XST(1)-XSK))
      FSA1 = SQRT((XST(3)-XSK)/(XST(2)-XSK))
      FS = FS*FSA1
      FA(IW)=(BETAN(IW)/FS-FAA)/(XSK-Y)
    1 CONTINUE
      IF(I.EQ.2) GO TO 30
      XP1=-1.+HCSPAC
      XP2=XP1+CSPACE
      XP4=XST(1)-HFSPAC
      XP3=XP4-FSPACE
      FS1=BETAM(1)/ SQRT((1.+XP1)*(XST(1)-XP1))
      FS2=BETAM(2)/ SQRT((1.+XP2)*(XST(1)-XP2))
      FS3=BETAM(LPM-2)/ SQRT((1.+XP3)*(XST(1)-XP3))
      FS4=BETAM(LPM-1)/ SQRT((1.+XP4)*(XST(1)-XP4))
      FSA1 = SQRT((XST(2)-XP1)/(XST(3)-XP1))
      FSA2 = SQRT((XST(2)-XP2)/(XST(3)-XP2))
      FSA3 = SQRT((XST(2)-XP3)/(XST(3)-XP3))
      FSA4 = SQRT((XST(2)-XP4)/(XST(3)-XP4))
      FS1 = FS1*FSA1
      FS2 = FS2*FSA2
      FS3 = FS3*FSA3
      FS4 = FS4*FSA4
      FP1=(FS1-FAA)/(XP1-Y)
      FP2=(FS2-FAA)/(XP2-Y)
      FP3=(FS3-FAA)/(XP3-Y)
      FP4=(FS4-FAA)/(XP4-Y)
      IF(IU3.EQ.2) GO TO 21
      IF(IU3.EQ.LPM1) GO TO 22
      IF(IU3.EQ.LPK) GO TO 51
      FA(IU3)=0.5*(FA(IU3-1)+FA(IU3+1))
      GO TO 30
   51 BETJ=2.*BETAN(LPK)-BETAN(LPK+1)
      XOA=XBET-FSPACE
      FPW=BETJ/SQRT((1.+XOA)*(XST(1)-XOA))
      FPWA = SQRT((XST(2)-XOA)/(XST(3)-XOA))
      FPW=FPWA*FPW
      FLPK=(FPW-FAA)/(XOA-Y)
      FA(IU3)=0.5*(FA(IU3+1)+FLPK)
      GO TO 30
   21 FA(IU3)=(FP1+FP2)/2.
      GO TO 30
```

```
   22 FA(IU3)=(FP3+FP4)/2.
   30 XI=0.
      LPM3=LPM-3
      SPACE=CSPACE
      DO 15 JA=2,LPM3,2
      IF(JA.GE.LPK) SPACE=FSPACE
   15 XI=XI+(FA(JA)+4.*FA(JA+1)+FA(JA+2))*SPACE/3.
      IF(1.EQ.2) GO TO 35
      XI23=0.5*HCSPAC*(FP1+FA(2))+(FA(LPM-1)+FP4) *0.5*HFSPAC
      XKI=41.
      KU=39
      LPMA=LPM-5
      IF(IU3.GE.LPMA) XKI=201.
      IF(IU3.GE.LPMA) KU=199
      BOZ=(BETAM(1)-BETAN(1))/XKI
      BOY=(BETAN(LPM)-BETAM(LPM1))/XKI
      HFF=HFSPAC/XKI
      HFH=HCSPAC/XKI
      FT3=FP1
      FU3=FP4
      XI4=0.
      XI1=0.
      DO 202 ITM=1,KU,2
      FT1=FT3
      FU1=FU3
      XM2=XST(1)-HFSPAC+HFF*FLOAT(ITM)
      XM3=XM2+HFF
      XT2=-1.+HCSPAC-HFH*FLOAT(ITM)
      XT3=XT2-HFH
      BETA2=BETAM(LPM1)+BOY*FLOAT(ITM)
      BETA3=BETA2+BOY
      BETT2=BETAM(1)-BOZ*FLOAT(ITM)
      BETT3=BETT2-BOZ
      FS2=BETA2/SQRT((1.+XM2)*(XST(1)-XM2))
      FS3=BETA3/SQRT((1.+XM3)*(XST(1)-XM3))
      FV2=BETT2/SQRT((1.+XT2)*(XST(1)-XT2))
      FV3=BETT3/SQRT((1.+XT3)*(XST(1)-XT3))
      FS2A = SQRT((XST(2)-XM2)/(XST(3)-XM2))
      FS3A = SQRT((XST(2)-XM3)/(XST(3)-XM3))
      FV2A = SQRT((XST(2)-XT2)/(XST(3)-XT2))
      FV3A = SQRT((XST(2)-XT3)/(XST(3)-XT3))
      FS2 = FS2*FS2A
      FS3 = FS3*FS3A
      FV2 = FV2*FV2A
      FV3 = FV3*FV3A
      FU2=(FS2-FAA)/(XM2-Y)
      FU3=(FS3-FAA)/(XM3-Y)
      FT2=(FV2-FAA)/(XT2-Y)
      FT3=(FV3-FAA)/(XT3-Y)
      XI4=XI4+HFF*(FU1+FU2*4.+FU3)/3.
  202 XI1=XI1+HFH*(FT1+FT2*4.+FT3)/3.
      XA4=BETAN(LPM)*2.*SQRT(HFF)/(AB2*(XST(1)-Y))
      XA4A = SQRT((XST(2)-XST(1))/(XST(3)-XST(1)))
      XA4 = XA4*XA4A
      XI4=XI4+XA4
      XA1=BETAN(1)*2.*SQRT(HFH)/(AB2*(-1.-Y))
      XA1A = SQRT((XST(2)+1.)/(XST(3)+1.))
      XA1 = XA1*XA1A
      XI1=XI1+XA1
      XI=(XI+XI23+XI1+XI4)*AB3/PAI
```

```
      XI=X1+BEC*ALOG((XST(1)-Y-HFF)/(1.+Y-HFH))/PAI
      XXI1=-XI
      GO TO 36
   35 XR1=-1.+0.5*HCSPAC
      XR2=XR1+HCSPAC
      XR4=XST(1)-0.5*HFSPAC
      XR3=XR4-HFSPAC
      FT1=0.5*(BETAN(1)+BETAM(1))/ SQRT((1.+XR1)*(XST(1)-XR1))
      FT2=0.5*(BETAM(1)+BETAN(2))/ SQRT((1.+XR2)*(XST(1)-XR2))
      FT3=0.5*(BETAN(LPM-1)+BETAM(LPM-1))/ SQRT((1.+XR3)*(XST(1)-XR3))
      FT4=0.5*(BETAM(LPM-1)+BETAN(LPM))/ SQRT((1.+XR4)*(XST(1)-XR4))
      FT1A = SQRT((XST(2)-XR1)/(XST(3)-XR1))
      FT2A = SQRT((XST(2)-XR2)/(XST(3)-XR2))
      FT3A = SQRT((XST(2)-XR3)/(XST(3)-XR3))
      FT4A = SQRT((XST(2)-XR4)/(XST(3)-XR4))
      FT1 = FT1*FT1A
      FT2 = FT2*FT2A
      FT3 = FT3*FT3A
      FT4 = FT4*FT4A
      FR1=(FT1-FAA)/(XR1-Y)
      FR2=(FT2-FAA)/(XR2-Y)
      FR3=(FT3-FAA)/(XR3-Y)
      FR4=(FT4-FAA)/(XR4-Y)
      XIP1=0.5*HCSPAC*(FR1+FR2)+0.5*HFSPAC*(FR3+FR4)
      XIP2=0.25*HCSPAC*(FR2+FA(2))+0.25*HFSPAC*(FA(LPM-1)+FR3)
      XI23=XIP1+XIP2
      XMI=21.
      XMI2=42.
      MU=21
      M2=MU-2
      LPMA=LPM-5
      IF(IU2.GE.LPMA) XMI=101.
      IF(IU2.GE.LPMA) XMI2=202.
      IF(IU2.GE.LPMA) MU=101
      IF(IU2.GE.LPMA) M2=MU-2
      BETY=(BETAN(LPM)-BETAM(LPM-1))/XMI2
      BESS=0.5*(BETAN(LPM)+BETAM(LPM-1))
      HSP6=0.5*HFSPAC/XMI
      FQ3=FR4
      BETY1=(BETAM(1)-BETAN(1))/XMI2
      BESS1=0.5*(BETAM(1)+BETAN(1))
      HSP61=0.5*HCSPAC/XMI
      FQ31=FR1
      XI1=0.
      XI4=0.
      DO 129 IL=1,M2,2
      FQ1=FQ3
      FQ11=FQ31
      X2=XST(1)-HSP6*FLOAT(MU-IL)
      X3=X2+HSP6
      X21=-1.+HSP61*FLOAT(MU-IL)
      X31=X21-HSP61
      BETA2=BESS+BETY*FLOAT(IL)
      BETA3=BESS+BETY*FLOAT(IL+1)
      BETA21=BESS1-BETY1*FLOAT(IL)
      BETA31=BETA21-BETY1
      FU21=BETA21/ SQRT((1.+X21)*(XST(1)-X21))
      FU31=BETA31/ SQRT((1.+X31)*(XST(1)-X31))
      FU21A = SQRT((XST(2)-X21)/(XST(3)-X21))
      FU31A = SQRT((XST(2)-X31)/(XST(3)-X31))
```

```
      FU21 = FU21*FU21A
      FU31 = FU31*FU31A
      FQ21=(FU21-FAA)/(X21-Y)
      FQ31=(FU31-FAA)/(X31-Y)
      FU2=BETA2/ SQRT((1.+X2)*(XST(1)-X2))
      FU3=BETA3/ SQRT((1.+X3)*(XST(1)-X3))
      FU2A = SQRT((XST(2)-X2)/(XST(3)-X2))
      FU3A = SQRT((XST(2)-X3)/(XST(3)-X3))
      FU2 = FU2*FU2A
      FU3 = FU3*FU3A
      FQ2=(FU2-FAA)/(X2-Y)
      FQ3=(FU3-FAA)/(X3-Y)
      XI1=XI1+HSP61*(FQ11+FQ21+4.+FQ31)/3.
  129 XI4=XI4+HSP6*(FQ1+4.*FQ2+FQ3)/3.
      XIA=2.*SQRT(HSP6)*BETAN(LPM)/(AB2*(XST(1)-Y))
      XIAA = SQRT((XST(2)-XST(1))/(XST(3)-XST(1)))
      XIA = XIA*XIAA
      XI4=XI4+XIA
      XIB=2.*SQRT(HSP61)*BETAN(1)/(AB2*(-1.-Y))
      XIBA = SQRT((XST(2)+1)/(XST(3)+1.))
      XIB = XIB*XIBA
      XI1=XI1+XIB
      XI=(XI+XI1+XI23+XI4)*AB3/PAI
      XI=XI+BEC*ALOG((XST(1)-Y-HSP6)/(1.+Y-HSP61))/PAI
      XXI1=-XI
   36 CONTINUE
C-------I2-----------
C----------IF Y IS LESS THAN ZERO, THIS IS A
C-----REGULAR INTEGRAL, WHILE Y .GE. 0, THIS IS A
C-----SINGULAR INTEGRAL.
C     BUT THIS IS TREATED AS A SINGULAR INTEGRAL ANYWAY
      CGAP = XST(1)/41.
      DO 81 LSI = 1,41
      XLSI = CGAP*FLOAT(LSI-1)
      CSA = (XLSI+1.)*(XST(1)-XLSI)*(XLSI-XST(3))
      CSB = XLSI-XST(2)
      CSC = SQRT(CSB/CSA)
   81 FXLS(LSI) = (CSC-1./AB3)/(XLSI-Y)
      XXI2 = 0.
      DO 82 LSJ = 1,39,2
   82 XXI2 = XXI2 + CGAP*(FXLS(LSJ)+4*FXLS(LSJ+1)+FXLS(LSJ+2))/3.
      ARGL=(XST(1)-CGAP-Y)/Y
      IF(Y.LT.0.) ARGL=-ARGL
      XXI2 = XXI2*AB3+ALOG(ARGL)
      CTA = (XST(1)+1.)*(XST(1)-XST(3))
      CTB = XST(1)-XST(2)
      ADXI2 = 2.*SQRT(CGAP)*SQRT(CTB/CTA)/(XST(1)-Y)*AB3
      XXI2 = XXI2+ADXI2
      XXI2 = -XXI2
C-----I3----------
C     USE CHEBYSHEV-GAUSS QUADRATURE.
C     AJ(I) ARE ALREADY CALCULATED IN SUBROUTINE FIINTL
C     AND PASSED ONTO HERE BY COMMON STATEMENT.
      XXI3 = 0.
      BPC5 = (XST(1)+XST(2))*.5
      CMB5 = (XST(2)-XST(1))*.5
      A31 = (BPC5+1.)/CMB5
      A32 = (-BPC5+XST(3))/CMB5
      DO 120 ISUM = 1,NCHBY
      HA1 = 1.-AJ(ISUM)
```

```
      HA2 = (AJ(ISUM)+A31)*(A32-AJ(ISUM))
      SHA2 = SQRT(HA2)
      F3I3 = HA1/SHA2
      F3AI3 = CMB5*AJ(ISUM)+BPC5-Y
  120 XXI3 = XXI3+F3I3/F3AI3
      XXI3 = XXI3*PAI/NCHBY
      UU22 = COS(ALFA1+GAMMA)/COS(XST(5)+GAMMA)
      HX3 = CCC1-ALOG(UU22)/PAI
      XXI3 = XXI3*AB3*HX3
C-----I4----------
C     USE CHEBYSHEV-GAUSS QUADRATURE FORMULA---
C-----BBETAN2(I) ARE ALREADY CALCULATED IN
C     SUBROUTINE FIINTL AND PASSED ONTO HERE BY
C     COMMON STATEMENT.
      FPC5 = (XSI(3)+XST(2))*.5
      FMC5 = (XST(3)-XST(2))*.5
      A41 = (FPC5+1.)/FMC5
      A42 = (FPC5-XST(1))/FMC5
      XXI4 = 0.
      DO 130 ISUM = 1,NCHBY
      RAX = (BBTAN2(ISUM)+PAI)*(1.+AJ(ISUM))
      RBX = (AJ(ISUM)+A41)*(AJ(ISUM)+A42)
      SRBX = SQRT(RBX)
      RCX = RAX/SRBX
      RDX = FMC5*AJ(ISUM)+FPC5-Y
  130 XXI4 = XXI4 + RCX/RDX
      XXI4 = XXI4*PAI/NCHBY
      XXI4 = -XXI4*AB3/PAI
      XXII = XXI1+XXI2+XXI3+XXI4
      RETURN
      END

      SUBROUTINE OFSIMS(ANS5)
      DIMENSION S2SR(101),S2KER(101),XST(5)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON SIGMA,SBETA,XXM,ICPI,SARCOO(513)
      COMMON IDJL,XA,XB,XC,TANG,LP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(5),CCC1,CLE,ERC,YYY,XM,ITERA,SYSIO(5),SXSIOO(5),YYS(5)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XOX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
      PAI=3.1415926554
C     THIS SUBROUTINE CALLED FROM OXFVEW.
C     USE SIMPSONTS RULE.
      DO 1 IMO = 1,5
    1 XST(IMO) = YXS(IMO)
      CDE = COS(DELTA)
      SDE = SIN(DELTA)
C  NS2 SHOULD HAVE A FACTOR OF 4.
C NS2=LPMM=LPM2
      NS21 = NS2+1
      NS2A = NS2-1
      S2GAP = (XST(3)-XST(2))/NS2
      UU2 = COS(ALFA1+GAMMA)/COS(XST(5)+GAMMA)
      DO 2 IS2 = 1,NS21
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```
      XS2 = XST(2)+S2GAP*(IS2-1)
      XKD = XS2*CDE
      XMAS = XS2-XST(4)*SDE
      XMAS2 = XMAS**2
      ASD = XST(4)*CDE
      ASD2 = ASD**2
      DWDX = DGAP*XKD/((XMAS2+ASD2)*PAI)
      IF (IS2.EQ.1) GO TO 3
      IF (IS2.EQ.NS21) GO TO 4
      CALL G2 (XS2,ANSG2,IS2)
C     G2 CALCULATES G2 WITH XSI GIVEN.
      EG2 = EXP(-ANSG2)
      IF(IJ.EQ.27) ANSG2S(IS2)=ANSG2
      S2KER(IS2) = EG2*DWDX/UU2
      GO TO 2
    3 CONTINUE
      S2KER(1) = DWDX/SQRT(1.+SIGMA)
      ANSG2S(IS2)=ALOG(SQRT(1.+SIGMA)/UU2)
      GO TO 2
    4 CONTINUE
      S2KER(NS21) = DWDX/UU2
      ANSG2S(IS2)=0.
    2 CONTINUE
      S2SR(1) = 0.
      DO 10 JS2 = 1,NS2A,2
   10 S2SR(JS2+2) = S2SR(JS2)
     1+(S2KER(JS2)+4.*S2KER(JS2+1)+S2KER(JS2+2))*S2GAP/3.
      IF(IJ.NE.27) GO TO 40
      SARC2(1)=0.
      DO 50 ISARC=2,NS2,2
   50 S2SR(ISARC)=.5*(S2SR(ISARC-1)+S2SR(ISARC+1))
      DO 30 ISARC=1,NS21
   30 SARC2(ISARC)=S2SR(ISARC)
   40 CONTINUE
      ANS5 = S2SR(NS21)
      RETURN
      END

      SUBROUTINE F1INTL(YINT,KCTRL)
      DIMENSION XST(5),RU3(100)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON SIGMA,SBETA,XXM,ICPI,SARC00(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(5),CCC1,CLE,ERC,YYY,XM,ITERA,SXSIO(5),SXSIOO(5),YXS(5)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XOX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TBAJS(100),WGAUS(100),NGAUS
C     SUBROUTINE F1INTL CALCULATES THE INTEGRALS IN F(1)
C     ISHARP = 0 FOR SHARP L.E.FOILS.
C     ISHARP = 1 FOR ROUNDED L.E.FOILS.
C     IF FOILS HAVE ROUNDED L.E., CHEBYSHEV-GAUSS
C     QUADRATUE
C     QUADRATURE FORMULA CAN NOT BE USED.  SINCE BETA
C     IS NOT A SMOOTH FUNCTION.
C     NCHBY = NUMBER OF CHEBYSHEV-GAUSS QUADRATURE CONTROL POINTS.
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      PAI = 3.141592654
      IF(ICP1.EQ.0) GO TO 9
      DO 70 IQ = 1,5
   70 XST(IQ) = XSN(IQ)
      GO TO 12
    9 DO 11 IM = 1,5
   11 XST(IM) = YXS(IM)
   12 CONTINUE
    5 DN1 = (XST(1)+1.)*.5
      DN2 = (XST(1)-1.)*.5
      A11 = (DN2-XST(2))/DN1
      A12 = (DN2-XST(3))/DN1
      BC5 = (XST(1)+XST(2))*.5
      CMB5=(XST(2)-XST(1))*.5
      A31 = (BC5+1.)/CMB5
      A32 = (-BC5+XST(3))/CMB5
      FCA5 = (XST(3)-XST(2))*.5
      FC15 = (XST(3)+XST(2))*.5
      A41 = (FC15+1.)/FCA5
      A42 = (FC15-XST(1))/FCA5
      SPACE2 = (XST(3)-XST(2))/LPMM
C     READ LPMM FOR THE SECOND ARC.
      IF(KCTRL.GE.2) GO TO 100
      IF(IJ.GE.2) GO TO 100
      CSPACE = (1.+XST(1))/FLOAT(LPK)
      FSPACE = CSPACE/FLOAT(LPM-LPK)
      IOM = 1
      XCHCK = -1.
      SPACE=CSPACE
      DO 20 ICHBY=1,NCHBY
      NCH=NCHBY-ICHBY+1
      AJ(ICHBY)=COS((2*NCH-1)*PAI/(2*NCHBY))
      XKSI=DN1*AJ(ICHBY)+DN2
      IF(ITERA.EQ.1) GO TO 488
   22 IF(XCHCK.GE.XKSI) GO TO 21
      IF(IOM.GE.LPK) SPACE = FSPACE
      XCHCK = XCHCK+SPACE
      IOM = IOM+1
      GO TO 22
C  XKSI EXISTS BTW XSI(IOM-1) AND XSI(IOM)
   21 CONTINUE
      IOMA = IOM-1
      BBTAN(ICHBY) = BETAN(IOM)+(BETAN(IOM)-BETAN(IOMA))
     X*(XKSI-XCHCK)/SPACE
C     BBTAN IS USED FOR CHEBYCHEV-GAUSS INSTEAD OF BETAN.
      GO TO 20
  488 BBTAN(ICHBY) = SBETA
C BETAN FOR ITERA.EQ.1 IS SPECIFIED IN OFSIM1.
   20 CONTINUE
  100 CONTINUE
      IF(KCTRL.EQ.4) GO TO 4
      IF (KCTRL.EQ.3) GO TO 3
      IF (KCTRL.EQ.2) GO TO 2
      IF (ISHARP.EQ.1) GO TO 10
      YINT  = 0.
      DO 110 ISUM = 1,NCHBY
      ABC = (AJ(ISUM)+A11)/(AJ(ISUM)+A12)
  110 YINT  = YINT +BBTAN(ISUM)*SQRT(ABC)
      YINT = YINT*PAI/NCHBY
      GO TO 1000
```

```
   10 CONTINUE
C  THIS IS THE CASE OF HANDLING RNDED L. E. .
      NOF = 0
      XCA = 0.
      CALL OFSIM1(YINT,NOF,XCA)
C     XCA IS DUMMY, ONLY USED FOR F(5) INDXFNEW.
      GO TO 1000
    2 CONTINUE
      SINC = XST(1)/21.
      DO 60 ITE = 1,21
      XYIN = FLOAT(ITE-1)*SINC
      RU1 = XYIN-XST(2)
      RU2 = (XYIN+1.)*(XST(1)-XYIN)*(XYIN-XST(3))
      RU3(ITE) = SQRT(RU1/RU2)
   60 CONTINUE
      YINT=0.
      DO 61 ILO = 1,19,2
   61 YINT = YINT+SINC*(RU3(ILO)+4.*RU3(ILO+1)+RU3(ILO+2))/3.
      ADIN = XST(1)-XST(2)
      ADTM = (XST(1)+1.)*(XST(1)-XST(3))
      ADN = SQRT(ADIN/ADTM)*2.*SQRT(SINC)
      YINT = YINT+ADN
      GO TO 1000
    3 CONTINUE
C-----INTEGRAL FOR I3.
C  AJ(N) IS CALCULATED AND STORED
      YINT = 0.
      DO 120 ISUM = 1,NCHBY
      AB1 = 1.-AJ(ISUM)
      AB2 = (AJ(ISUM)+A31)*(A32-AJ(ISUM))
      SQAB2 = SQRT(AB2)
      ABC = AB1/SQAB2
  120 YINT = YINT+ABC
      YINT = YINT*PAI/NCHBY
      GO TO 1000
C-----INTEGRAL FOR I4
C     SINCE BETA(N) BTWN TCT AND TFT ARE
C     EXPECTED TO BE ALWAYS SMOOTH, USE GAUSS-
C     CHEBYSHEV QUADRATURE FORMULA.
C     AJ(N) IS ALREADY CALCULATED.
C     IF THIS IS THE FIRST CASE FOR BETAN2,
C     USE A CONSTANT FOR BETAN2.
C     BBTAN2 IS USED FOR CHEVY-GAUSS INSTEAD OF BETAN2.
    4 CONTINUE
      IF(ITERA.GE.2) GO TO 150
      IF(IJ.GE.2) GO TO 191
C  SBETA2 MUST BE READ FOR THE FIRST RUN.
      DO 180 ICHBY = 1,NCHBY
  180 BBTAN2 (ICHBY) = SBETA2
      NS21=NS2+1
      DO 185 IOC=1,NS21
  185 BETAN2(IOC)=SBETA2
      GO TO 181
  150 CONTINUE
      IF(IJ.GE.2) GO TO 181
      IOMM = 1
      XCHCK = XST(2)
      DO 170 ICHBY = 1,NCHBY
      XKSI = FCA5*AJ(ICHBY)+FC15
  152 IF(XCHCK.GE.XKSI) GO TO 151
```

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      XCHCK = XCHCK + SPACE2
      IOMM = IOMM+1
      GO TO 152
  151 CONTINUE
      IOMMA = IOMM-1
      BBTAN2(ICHBY) = BETAN2(IOMM)
     1+(BETAN2(IOMM)-BETAN2(IOMMA))*(XKSI-XCHCK)/SPACE2
      ILM=ICHBY
      XKSI = FCAS*AJ(ILM  )+FC15
      WRITE(6,250) ILM,BBTAN2(ILM),XKSI
  250 FORMAT(15X,*I=*,I3,2X,*BBTAN2=*,E14.7,2X,*XKSI=*,E14.7)
  170 CONTINUE
  181 CONTINUE
      YINT = 0.
      DO 190 ISUM = 1,NCHBY
      AB1 = (BBTAN2(ISUM)+PAI)*(1.+AJ(ISUM))
      AB2 = (AJ(ISUM)+A41)*(AJ(ISUM)+A42)
      SQAB2 = SQRT(AB2)
  190 YINT = YINT + AB1/SQAB2
      YINT = YINT*PAI/NCHBY
 1000 CONTINUE
      RETURN
      END

      SUBROUTINE G2 (XS2,AG2,IS2)
      DIMENSION    XSI(5),XI21S(200),XI22S(200),XI23S(200),XI24S(200)
      COMMON YCCC,SBETA2
      COMMON XITN(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFAI,GAMMA
      COMMON SIGMA,SBETA,XXM,ICPI,SARCOO(513)
      COMMON IOJL,XA,XB,XC,TANS,EP,YC,YP,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(5),CCCI,CLE,ERC,YYY,XM,ITERA,SXSIO(5),SXSIOO(5),YXS(5)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XOX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
C     THIS SUBROUTINE IS CALLED BY OFSIM5.
C     THIS SUBROUTINE CALCULATES FUNCTION G2(XS2) WHICH
C     INCLUDES I21(XS2) TO I24(XS2).
C     XS2 IS XSI- AG2 IS THE SOLUTION OF INTEGRALS.
      DO 1 IGP=1,5
    1 XST(IGP)=YXS(IGP)
      PAI = 3.141592654
      IF (IJ.GE.34) GO TO 100
C---I21(XSI)----.
C     THE SAME INTEGRATION AS THAT IN
C     SUBROUTINE CAVITY FOR GC(XSI)
      NOF = 3
      CALL OFSIM1(ANS,NOF,XS2)
      XI21 = ANS
      IF(IJ.EQ.27) XI21S(IS2) = XI21
C----I22(XSI)----.
C     USE THE SAME SUBROUTINE IC2 AS
C     USED IN CAVITY WITH ISIC=1.
      ISIC=1
      CALL IC2(SR,SM,XS2,ISIC)
      XI22 = SR
C     NOTE THAT SM IS DUMMY VARIABLE.
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```
      IF(IJ.EQ.27) XI22S(IS2) = XI22
C----I23(XSI)----.
C     USE CHEBYCHEV-GAUSS QUADRATURE FORMULA
C       IN EXACTLY SIMILAR MANNER TO THAT IN
C        OFSIM3 FOR I3.
      XI23 = 0.
      BPC5 = (XST(1)+XST(2))*.5
      CMB5 = (XST(2)-XST(1))*.5
      A31 = (BPC5 + 1.)/CMB5
      A32 = (-BPC5 + XST(3))/CMB5
      DO 2 ISUM = 1,NCHBY
      HA1 = 1.-AJ(ISUM)
      HA2 = (AJ(ISUM) + A31)*(A32-AJ(ISUM))
      SHA2 = SQRT(HA2)
      F3I3 = HA1/SHA2
      F3AI3 = CMB5*AJ(ISUM)+BPC5-XS2
    2 XI23 = XI23+F3I3/F3AI3
      XI23 = XI23*PAI/NCHBY
      IF (IJ.EQ.27) XI23S(IS2) = XI23
C-----I24-----.
C     USE CHEBYCHEV-GAUSS QUADRATURE
C        FORMULA BY ASSUMING THAT
C        THE KERNEL FCN. IS SMOOTH.
      HU = (XS2+1.)*(XS2-XST(1))*(XST(3)-XS2)
      HV = XS2-XST(2)
      HW = SQRT(HU/HV)
      FPC5 = (XST(3)+XST(2))*.5
      FMC5 = (XST(3)-XST(2))*.5
      A41 = (FPC5+1.)/FMC5
      A42 = (FPC5-XST(1))/FMC5
      XI24 = 0.
      DO 10 ISUM = 1, NCHBY
      TPA1 = AJ(ISUM)+A41
      TPA2 = AJ(ISUM)+A42
      STP = SQRT(TPA1*TPA2)
      F4T = (BETAN2(ISUM)+PAI)*(1.+AJ(ISUM))/STP
C     BETAN2 IS CHEBY-GAUSS VERSION FOR BETA ON THE SECOND ARC.
      F4A = FMC5*AJ(ISUM)+FPC5-XS2
      ST2 = SQRT(1.-AJ(ISUM)**2)
      F4B = FMC5 *ST2*(BETAN2(IS2 )+PAI)/HW
   10 XI24 = XI24+(F4T-F4B)/F4A
      XI241 = XI24*PAI/NCHBY
C     BETAN2 IS USED FOR SIMPSONTS RULE.
      XLG = ALOG((XST(3)-XS2)/(XS2-XST(2)))
C     IS2 IS TRANSFERRED THROUGH G2-ARGUMENT.
      XI242 = XLG*(BETAN2(IS2)+PAI)/HW
      XI24 = XI241+XI242
      IF(IJ.EQ.27) XI24S(IS2) = XI24
      GO TO 101
  100 XI21 = XI21S(IS2)
      XI22 = XI22S(IS2)
      XI23 = XI23S(IS2)
      XI24 = XI24S(IS2)
  101 XS2A = -XI21/PAI-XI22
      XS2B = CCC1-ALOG(COS(ALFA1+GAMMA)/COS(XST(5)+GAMMA))/PAI
      XS2C = XS2B*XI23
      XS2D = -XI24/PAI
      IF(IJ.EQ.27) WRITE(5,225) XS2D
  225 FORMAT(1X,*XS2D=*,F20.10)
      AG2 = (XS2A+XS2C+XS2D)*HW
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      RETURN
      END

      SUBROUTINE RMINT (SR,SM,MIQ)
      DIMENSION XST(5)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAV2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON SIGMA,SBETA,XXM,ICPI,SARCOD(513)
      COMMON IDUE,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(5),CCC1,CLE,ERC,YYY,XM,ITERA,SXSIG(5),SXSIOO(5),YXS(5)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
      PAI = 3.141592654
      IF (ICPI.EQ.0) GO TO 10
      DO 12 I5 = 1,5
   12 XST(I5) = XSN(I5)
      GO TO 11
   10 DO 1 IS = 1,5
    1 XST(IS) = YXS(IS)
   11 CONTINUE
      XX1 = XST(4)*SIN(DELTA)
      YY1 = XST(4)*COS(DELTA)
      YY12 = YY1**2
      CB5 = (XST(2)-XST(1))*.5
      BC5 = (XST(1)+XST(2))*.5
      A31 = (BC5+1.)/CB5
      A32 = (-BC5+XST(3))/CB5
      BM15 = (XST(1)-1.)*.5
      BP15 = (XST(1)+1.)*.5
      A11 = (BM15-XST(2))/BP15
      A12 = (BM15-XST(3))/BP15
      FPC5 = (XST(3)+XST(2))*.5
      FMC5 = (XST(3)-XST(2))*.5
      A41 = (FPC5+1.)/FMC5
      A42 = (FPC5-XST(1))/FMC5
      IF(MIQ.EQ.4) GO TO 4
      IF (MIQ.EQ.3) GO TO 3
      IF (MIQ.EQ.2) GO TO 2
C     AJ(I) ARE ALREADY CALCULATED IN SUBROUTINE
C           TFINTLT AND STORED IN COMMON AREA.
      SR=0.
      SM=0.
      DO 20 ISUM = 1,NCHBY
      GX1 = 1.-AJ(ISUM)
      GY1 = (AJ(ISUM)+A31)*(A32-AJ(ISUM))
      SGY1 = SQRT(GY1)
      FF3 = GX1/SGY1
      FX1 = CB5*AJ(ISUM)+BC5
      FX2 = FX1-XX1
      FX22=FX2**2
      FX3 = FX22+YY12
      FF31 = FX2/FX3
      FF32 = YY1/FX3
      SR = SR+FF3*FF31
   20 SM = SM+FF3*FF32
```

```
      SR = SR*PAI/NCHBY
      SM = SM*PAI/NCHBY
      GO TO 1000
    2 CONTINUE
      IF (ISHARP.EQ.1) GO TO 100
C     ISHARP = 1 MEANS THAT THE FOIL HAS ROUNDED L.E.
C     SO THAT THE SIMPSONTS RULE IS USED,
C     ISHARP = 0 MEANS THAT THE FOIL HAS SHARP L.E.
C     SO THAT CHEBYSHEV GAUSS FORMULA CAN BE USED AS BELOW.
      SR = 0
      SM = 0
      DO 30 ISUM = 1,NCHBY
      ST11 = AJ(ISUM)+A11
      ST12 = AJ(ISUM)+A12
      FK1 = BBTAN(ISUM)*SQRT(ST11/ST12)
      UN1 = BP15*AJ(ISUM)+BM15-XX1
      UN12 = UN1**2
      UN13 = UN12+YY12
      FK11 = UN1/UN13
      FK12 = YY1/UN13
      SR = SR+FK1*FK11
   30 SM = SM+FK1*FK12
      SR = SR*PAI/NCHBY
      SM = SM*PAI/NCHBY
      GO TO 1000
  100 CONTINUE
C     THIS IS THE CASE THAT THE FOIL HAS ROUNDED L.E.
      NOF = 1
      XCA = 0.
      CALL OFSIM1(SR,NOF,XCA)
C  XCA IS DUMMY----ONLY USED FOR F(5) IN OXFNEW.
      NOF=2
      CALL OFSIM1(SM,NOF,XCA)
      GO TO 1000
    3 CONTINUE
C     USE CHEBYSHEV-GAUSS FORMULA SINCE BETA
C     IN THIS REGION IS SMOOTH.
C     BBTAN2 (ISUM) ARE ALREADY CALCULATED AT TFINTLT.
      SR = 0.
      SM = 0.
      DO 50 ISUM = 1,NCHBY
      PSL = (BBTAN2(ISUM)*PAI)*(1.+AJ(ISUM))
      PSM = (AJ(ISUM)+A41)*(AJ(ISUM)+A42)
      SQPSM = SQRT(PSM)
      FF4 = PSL/SQPSM
      PSN = FMC5*AJ(ISUM)+FPC5-XX1
      PSN2 = PSN**2
      FF41 = PSN/(PSN2+YY12)
      FF42 = YY1/(PSN2+YY12)
      SR = SR+FF4*FF41
      SM =SM+FF4*FF42
   50 CONTINUE
      SR = SR*PAI/NCHBY
      SM = SM*PAI/NCHBY
      GO TO 1000
    4 CONTINUE
C     XCA IS DUMMY, ONLY USED FOR IC2 IN F(5)
      XCA = 0.
      ISIC = 0
C     SUBROUTINE IC2 IS ALSO USED IN F(5).
```

```
      CALL IC2(SR,SM,XCA,ISIC)
 1000 RETURN
      END

      SUBROUTINE CAVITY (XCC,YCC)
C THIS SUBROUTINE IS CALLED FROM DXFNEW FOR F(5).
      DIMENSION CKEX(100),SKEY(100),ANSI1(100),SRI2(100),SIC3I3(100)
      DIMENSION SIC414(100),XSI(5)
      DIMENSION CAVXX(100),CAVYY(100)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALPAI,GAMMA
      COMMON SIGMA,SBETA,XXM,ICP1,SARCOD(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(5),CCC1,CLE,ERC,YYY,XM,ITEPA,SXSIO(5),SXSIOO(5),YXS(5)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
C XCCC IS THE CAVITY END POINT CALCULATED IN SUB. CAVITY.
      SQGM = SQRT(1.+SIGMA)
      CDEL = COS(DELTA)
      SDEL = SIN(DELTA)
      PAI = 3.141592654
      DO 1 LOA = 1,5
    1 XSI(LOA) = YXS(LOA)
      NCAV=60
      NCAV1=NCAV+1
      CAVS = (XSI(2)-XSI(1))/NCAV
C     LEAVE THE LAST POINT OF XSI = 0 SINCE THERE IS A
C        SINGULARITY FOR SINGLE SPIRAL VORTEX MODEL.
      DO 2 KLM = 1,NCAV1
      XCA = XSI(1) +CAVS* (KLM-1)
C     REAL PART OF OMEGA = BETA* PAI.
      IF (KLM.EQ.1) GO TO 3
      IF(KLM.EQ.NCAV1) GO TO 10
C-----IC1(XSI) CALCULATION, CALLING DFSIM1.
      IF (IJ.GE.34) GO TO 75
      NDF = 3
      CALL DFSIM1(ANS,NDF,XCA)
C     ANS IS A SOLUTION FOR IC1(XCI), XCI IS IDENTICAL TO XCA.
      IF (IJ.EQ.27) ANSI1(KLM) = ANS
      GO TO 76
   75 ANS = ANSI1(KLM)
   76 CONTINUE
C---- IC2(XSI) CALCULATION.
      IF(IJ.GE.34) GO TO 77
      ISIC = 1
      CALL IC2(SR,SM,XCA,ISIC)
C     ONLY SR IS UTILIZED-- SM IS FOR RMINT.
      IF (IJ.EQ.27) SRI2(KLM) = SR
      GO TO 78
   77 SR = SRI2(KLM)
   78 CONTINUE
C-----IC3 (XSI) CALCULATION-- USE CHEBYSHEV-GAUSS
C     QUADRATURE FORMULA.
      IF (IJ.GE.34) GO TO 80
      BPCS = (XSI(1)+XSI(2))*.5
```

```
      CMB5 = (XST(2)-XST(1))*.5
      A31 = (BPC5+1.)/CMB5
      A32 = (-BPC5+XST(3))/CMB5
      EK1 = XCA-XST(2)
      EK2 = (XCA+1.)*(XCA-XST(1))*(XCA-XST(3))
      EK3 = SQRT(EK1/EK2)
      EF5B = CMB5*EK3
      SIC3 = 0.
      DO 5 ISUM = 1,NCHBY
      EJ1=(AJ(ISUM)+A31)*(A32-AJ(ISUM))
      SEJ1 = SQRT(EJ1)
      EF3 = (1.-AJ(ISUM))/SEJ1
      EF3A = CMB5*AJ(ISUM)+BPC5-XCA
    5 SIC3 = SIC3+(EF3-EF5B*SQRT(1.-AJ(ISUM)**2))/EF3A
      SIC3 = SIC3*PAI/NCHBY
      SIC3 = SIC3+ALOG((XST(2)-XCA)/(XCA-XST(1)))*EK3
      IF(IJ.EQ.27) SIC3I3(KLM) = SIC3
      GO TO 81
   80 SIC3 = SIC3I3(KLM)
   81 CONTINUE
C-----IC4(XSI)----.
C     USE CHEBYSHEV-GAUSS QUADRATURE FORMULA
C        IN THE SAME MANNER AS THAT FOR I3 IN
C        OFSIM3.
      IF(IJ.GE.34) GO TO 82
      FPC5 = (XST(3)+XST(2))*.5
      FMC5 = (XST(3)-XST(2))*.5
      A41 = (FPC5+1.)/FMC5
      A42 = (FPC5-XST(1))/FMC5
      SIC4 = 0.
      DO 7 ISUM= 1,NCHBY
      RA = (BETAN2(ISUM)+PAI)*(1.+AJ(ISUM))
      RB = (AJ(ISUM)+A41)*(AJ(ISUM)+A42)
      SRB = SQRT(RB)
      RC = RA/SRB
      RD = FMC5*AJ(ISUM)+FPC5-XCA
    7 SIC4 = SIC4+RC/RD
      SIC4 = SIC4*PAI/NCHBY
      IF(IJ.EQ.27) SIC4I4(KLM)= SIC4
      GO TO 83
   82 SIC4 = SIC4I4(KLM)
   83 CONTINUE
C  HC(XSI) = 1/EK3  ALREADY CALCULATED.
      UU2 = COS(ALFA1+GAMMA)/COS(XST(5)+GAMMA)
      GC = (-ANS/PAI-SR+(CCC1-ALOG(UU2)/PAI)*SIC3
     1-SIC4/PAI)/EK3
      GO TO 25
    3 GC = BETAB+PAI
      GO TO 25
   10 GC=BETAC+PAI
C BETAB AND BETAC( BODY ANGLES AT B AND C) MUST BE SPEICIEED IN COMMON.
   25 CONTINUE
      XXS = XCA*CDEL
      YYT = XCA-XST(4)*SDEL
      YYT2 = YYT**2
      XXU = XST(4)*CDEL
      XXU2 = XXU**2
      XYB = YYT2+XXU2
      DWDX = DGAP*XXS/(XYB*PAI)
      CGC = COS(GC)
```

```
      SGC = SIN(GC)
      CFC = DWDX/SCGM
      CKEX(KLM) = CGC*CFC
      SKEY (KLM) = SGC*CFC
    2 CONTINUE
      CAVXX(1)=0.
      CAVYY(1)=0.
      DO 15 ICAV=3,NCAV1,2
      CAVXX(ICAV) = CAVXX(ICAV-2)+CAVS*(CKEX(ICAV-2)+4.*
     1CKEX(ICAV-1)+CKEX(ICAV))/3.
   15 CAVYY(ICAV) = CAVYY(ICAV-2)
     1+CAVS*(SKEY(ICAV-2)+4.*SKEY(ICAV-1)+SKEY(ICAV))/3.
      IF(IJ.EQ.27) GO TO 100
      GO TO 101
  100 DO 102 ICAV=1,NCAV1,2
      CAVX(ICAV)=CAVXX(ICAV)
  102 CAVY(ICAV)=CAVYY(ICAV)
  101 CONTINUE
      XCC=CAVX(NCAV1)
      YCC=CAVY(NCAV1)
      XCCC=XCC
      YCCC=YCC
      RETURN
      END

      SUBROUTINE IC2(SR,SM,XCA,ISIC)
      DIMENSION XKER1(100),XKER2(100),XST(5)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSQ2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON SIGMA,SBETA,XXM,ICPI,SARCOO(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YP,JBIGS,YLBIGS,BIGS,SMALS,DSS
      COMMON XSM(5),CCC1,CLE,ERC,YYY,XM,ITERA,SXSIO(5),SXSICO(5),YXS(5)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
      DO 1 IPN = 1,5
    1 XST(IPN) = YXS(IPN)
      XX1 = XST(4)*SIN(DELTA)
      YY1 = XST(4)*COS(DELTA)
      YY12 = YY1**2
C     ISIC = 0 FOR RMINT
C          = 1 IN CAVITY OF OFSIMS FOR F(5) AND IN CAVITY.
      SINC = XST(1)/21.
      DO 60 ITE = 1,21
      XYIN = FLOAT(ITE-1)*SINC
      RU1 = XYIN-XST(2)
      RU2 = (XYIN+1.)*(XST(1)-XYIN)*(XYIN-XST(3))
      RU3 = SQRT(RU1/RU2)
      RV1 = XYIN-XX1
      RV12 = RV1**2
      RV2 = RV12 + YY12
      RWR = RV1/RV2
      RWI = YY1/RV2
      IF (ISIC.EQ.1) RWR = 1./(XYIN-XCA)
C        RWI AND XKER2(I) BECOME DUMMY FOR ISIC = 1.
      XKER1(ITE) = RU3*RWR
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   60 XKER2(ITE) = RU3*RWI
      SR = 0.
      SM = 0.
      DO 61 ILO = 1,19,2
      SR = SR+SINC*(XKER1(ILO)+4.*XKER1(ILO+1)
     1+XKER1(ILO+2))/3.
   61 SM = SM+SINC*(XKER2(ILO)+4.*XKER2(ILO+1)
     1+XKER2(ILO+2))/3.
      ADT1 = XST(1)-XST(2)
      ADT2 = (XST(1)+1.)*(XST(1)-XST(3))
      ADT3 = SQRT(ADT1/ADT2)
      ADS1 = XST(1)-XX1
      ADS12 = ADS1**2
      ADS2 = ADS12+ YY12
      ADS3 = ADT3*2.*SQRT(SINC)
      ADRL=ADS3*ADS1/ADS2
      IF(ISIC.EQ.1) ADRL = ADS3/(XST(1)-XCA)
      ADIM = ADS3*YY1/ADS2
      SR = SR+ADRL
      SM = SM+ADIM
      RETURN
      END

      SUBROUTINE ARCS2(S2,XC,YC)
      COMMON/THICK/TH
C THIS IS CALLED FROM F(5) AFTER CAVITY SUBROUTINE.
C FOR S2, THE TOTAL ARC LENGTH S2 IS CALCULATED BY THIS SOUBROUTINE, BUT
C     FOR BETAN2 FINDING, ARCLEN AND BBBETA ARE USED AS FOR S1.
      PAI=3.141592654
      XZ=.5
      IF (TH.LE.1.E-6) GO TO 1
      YZ = (TH**2-.25)/(2.*TH)
      HGZ=ATAN(-XZ/YZ)
      XCMZ=XC-XZ
      YCMZ=YC-YZ
      AL=ATAN(XCMZ/YCMZ)
      BT=HGZ-AL
      PBT=BT/(2.*PAI)
      XCMZ2=XCMZ**2
      YCMZ2=YCMZ**2
      S2=2.*PAI*SQRT(XCMZ2+YCMZ2)*PBT
      GO TO 2
    1 S2 = 1.-XC
    2 CONTINUE
      RETURN
      END

      SUBROUTINE ARCLEN(XSS,XL,XH,IS1I2)
      COMMON/THICK/TH
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFAI,GAMMA
      COMMON SIGMA,SBETA,XXM,ICPI,SARCOO(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,UBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSV(5),CCC1,CLE,ERC,YYY,XM,ITERA,SXSIO(5),SXSIOO(5),YXS(5)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAV(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B2BB,C2CC
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```
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
C FOR PLANO-CONVEX CASCADE OF WADE AND ACOSTA.
      IF(IS1I2.EQ.1) GO TO 10
      XSS=XH-XL
      GO TO 11
   10 AT1=2.*XH-1.
      AT2=2.*XL-1.
      PX2=XCCC**2
      PY2=YCCC**2
      IF (TH.LE.1.E-6) GO TO 3
      CTH = (TH**2-.25)/TH
      CEND=PX2+PY2-XCCC*CTH*YCCC
      CONS=SQRT(CTH**2+4.*CEND+1.)
      AAT1=ASIN(AT1/CONS)
      AAT2=ASIN(AT2/CONS)
      XSS=.5*(AAT1-AAT2)*CONS
      GO TO 11
    3 XSS = XH-XL
   11 CONTINUE
      RETURN
      END

      SUBROUTINE XCYC(XCB,YCB,CX,CY)
C THIS IS CALLED FOR PLANO-CONVEX CASCADE.
      COMMON/THICK/TH
      XZ=.5
      IF (TH.LE.1.E-6) GO TO 3
      YZ = (TH**2-.25)/(2.*TH)
      UK=CY-YZ
      DK=CX-XZ
      IF(DK.EQ.0.) GO TO 1
      AK=UK/DK
      AK2=AK**2
      XZ2=XZ**2
      YZ2=YZ**2
      R2=XZ2+YZ2
      SR=SQRT(R2/(1.+AK2))
      XCB=XZ+SR
      IF(DK.LT.0.) XCB=XZ-SR
      YCB=AK*(XCB-XZ)+YZ
      GO TO 2
    1 CONTINUE
      XCB=XZ
      YCB=TH
      GO TO 2
    3 XCB = CX
      YCB = 0
    2 CONTINUE
      RETURN
      END

      SUBROUTINE SHAPE(X,Y,BETA,IS1I2)
      COMMON /THICK/TH
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSGPS(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON SIGMA,SBETA,XXM,ICPI,SARC00(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
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      COMMON XSA(5),CCC1,CLE,ERC,YYY,XM,ITERA,SXSIO(5),SXSIOO(5),YXS(5)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XOX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
C PLANO-CONVEX CASCADE CASE.
      PAI=3.141592653
      IF(IS1I2.EQ.1) GO TO 1
      BETA=0.
      Y=0.
      GO TO 2
    1 CONTINUE
      IF (TH.LE.1.E-6) GO TO 3
      PX2=XCCC**2
      PY2=YCCC**2
      CTH = -(TH**2-.25)/TH
      CEND=PX2+PY2-XCCC+CTH*YCCC
      YCO=CTH
      YCO2=YCO**2
      YSC=YCO2-4.*(X**2-X-CEND)
      SYS=SQRT(YSC)
      Y=(-YCO+SYS)*.5
      YOX=-(2.*X-1.)/(2.*Y+YCO)
      BETA=ATAN(YOX)-PAI
      GO TO 2
    3 CONTINUE
      Y = 0.
      BETA=-PAI
    2 CONTINUE
      RETURN
      END

      SUBROUTINE MOSEC(A,B,ER1,ER2,X,J,XLPA,IS1I2)
      J=0
      X1=A
      X2=B
    4 J=J+1
      IF(J.GE.800) GO TO 8
      CALL FARC(PFX1,XLPA,X1,IS1I2)
      CALL FARC(PFX2,XLPA,X2,IS1I2)
      X3=X1+(X2-X1)*PFX1/(PFX1-PFX2)
      CALL FARC(PFX3,XLPA,X3,IS1I2)
      IF(PFX3)1,2,3
    1 X2=X3
      X1=X1
      IF(A-B)10,10,11
   10 Y=X3-ER1
      IF(Y.LE.0.) Y=0.
      GO TO 12
   11 Y=X3+ER1
   12 CALL FARC(PFY,XLPA,Y,IS1I2)
      IF(PFY) 5,2,2
    3 X1=X3
      X2=X2
      IF(A-B) 20,20,21
   20 Z=X3+ER1
      GO TO 22
   21 Z=X3-ER1
   22 CALL FARC(PFZ,XLPA,Z,IS1I2)
      IF(PFZ)2,2,5
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```
    5 GO TO 4
    2 PP= ABS(PFX3)
      IF(PP-ER2) 6,6,4
    6 X=X3
      GO TO 7
    8 WRITE(6,9) J
    9 FORMAT(1X,2HJ=,I3)
      STOP
    7 RETURN
      END

      FUNCTION AITKEN(XX,YY,X,N)
      DIMENSION XX(1),YY(1),ZZ(21)
      IF (N)1,1,2
    1 AITKEN=YY(1)
      RETURN
    2 IF (N.GT.20) N=20
      M=N+1
      DO 3 K=1,M
    3 ZZ(K)=YY(K)
      DO 4 I=1,N
      DO 4 J=I,N
    4 ZZ(J+1)=ZZ(I)+(X-XX(I))*(ZZ(J+1)-ZZ(I))/(XX(J+1)-XX(I))
      AITKEN=ZZ(N+1)
      RETURN
      END

       SUBROUTINE DETERM (A,N,D)
C   DETERM  REVISED 02-28-73
       REAL M
       DIMENSION A(50,50),SAVEA(50,50)
       IF (N .EQ. 1)GO TO 46
       C = 1.
       NN = N
       DO 9 J = 1,NN
       DO 9 I = 1,NN
    9  SAVEA(I,J) = A(I,J)
       K = 1
       GO TO 13
   12  K = K + 1
   13  I = K + 1
       L = K
       GO TO 17
   16  I = I + 1
   17  IF (ABS(SAVEA(I,K)) .GT. ABS(SAVEA(L,K))) L = I
       IF (I .NE. NN)GO TO 16
       IF (L .EQ. K)GO TO 29
       J = K
C      ROW INTERCHANGE
       GO TO 23
   22  J = J + 1
   23  SAVEKJ = SAVEA(K,J)
       SAVEA(K,J) = SAVEA(L,J)
       SAVEA(L,J) = SAVEKJ
       IF (J .NE. NN)GO TO 22
       C = -C
   28  I = K + 1
       GO TO 31
   30  I = I + 1
   31  CONTINUE
```

```
      IF (SAVEA(K,K) .EQ. 0.) GO TO 48                                  02-20-73
      M = SAVEA(I,K) / SAVEA(K,K)
      SAVEA(I,K) = 0.
      J = K + 1
      GO TO 36
   35 J = J + 1
   36 SAVEA(I,J) = SAVEA(I,J) - M * SAVEA(K,J)
      IF (J .NE. NN)GO TO 35
      IF (I .NE. NN)GO TO 30
      IF (K .NE. (NN-1))GO TO 12
      D = 1.
      DO 43 I = 1,NN
      J = I
      D = D * SAVEA(I,J)
      IF (ABS(D) .LT. 1.E-36) GO TO 48
   43 CONTINUE
      D = D * C
      RETURN
   46 D = A(1,1)
      RETURN
   48 D = 0.
      WRITE (6,51)
      RETURN
   51 FORMAT(///5X,'ERROR MESSAGE FROM DETERM.'//
     1 5X,'MATRIX IS SINGULAR. DETERMINANT SET = 0.' //)
      END

C THIS GIVES BETA(X(XSI)).
      SUBROUTINE BBBETA(XX,BBETA,IS1I2)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON SIGMA,SBETA,XXM,ICPI,SARCOD(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLPIGS,BIGS,SMALS,DSS
      COMMON XSN(5),CCC1,CLE,ERC,YYY,XM,ITERA,SXSID(5),SXSIOD(5),YXS(5)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XOX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
      ER1=5.E-3
      ER2=5.E-3
      IF(IS1I2.EQ.1) GO TO 20
C IS1I2=0 FOR S1.
C       1 FOR S2.
      LPMAA=LPM-1
      SMALS=SARC(LP)
      IF(LP.EQ.LPM) GO TO 10
      DSS=SARC(LP)-SARC(LP+1)
      XLPA=XX
      GO TO 21
   20 SMALS=SARC2(LP)
      IF(LP.EQ.1)GO TO 111
      XLPA=XX
      DSS=SARC2(LP)-SARC2(LP-1)
   21 CONTINUE
      X1A=XLPA
    4 X1B=X1A+.001
      CALL FARC(FAR,XLPA,X1B,IS1I2)
```

```
      IF(FAR.LT.0.) GO TO 3
      X1A=X1B
      GO TO 4
    3 CALL MOSEC(X1A,X1B,ER1,ER2,XX,JII,X_PA,IS1I2)
      GO TO 11
   10 XX=0.
      GO TO 11
  110 XX=XCCC
   11 CALL SHAPE(XX,Y,RBETA,IS1I2)
      RETURN
      END

      SUBROUTINE FARC(FAR,XLPA,X1B,IS1I2)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALPA1,GAMMA
      COMMON SIGMA,SBETA,XX4,ICPI,SARCOO(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(5),CCC1,CLE,ERC,YYY,XM,ITERA,SXSIO(5),SXSIOO(5),YXS(5)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XOX
      COMMON XROUND,A2AA,B23B,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
      IF(XLPA.EQ.X1B) GO TO 1
      CALL ARCLEN(XSS,XLPA,X1B,IS1I2)
      GO TO 2 .
    1 XSS=0.
    2 CONTINUE
      FAR=DSS-XSS
      RETURN
      END
vv
```

6.0 LISTING OF PCASL

```
      READ(5,1321) SBETA ,SBETA2,SF4,BETAB,BETAC
      READ(5,551) LPMS,LPKS,LPM2,IFLAG,IREAD,ISHARP
      READ(5,201) NITER,MSTOP,MAXIT,NHK
      READ(5,202) ALFA1S,GAMMAS,SOLIS,   CAVLEN
      READ(5,229) DE,DG,DF
C CAVLEN IS A CAVITY LENGTH SPECIFIED.
      DO 592 IDELTA=1,6
  592 WRITE (6,591) (DELT(IDELTA,I),I=1,6)


      WRITE (6,5690) TH,XXM
      WRITE(6,5651) BETAB,BETAC
      WRITE(6,565) R,AAAA,BBBB,CCCC
      WRITE(6,566) A8,B8,C8,D8
      WRITE(6,567) XROUND,A2AA,B2BB,C2CC
      WRITE(6,1229) LPMS,LPKS,SBETA,IREAD,NCHEY
      WRITE(6,1324) DE,DG,DF,SF4
      WRITE(6,1521) SBETA2
  590 FORMAT (8F10.6)
  591 FORMAT (10X,*DELTA(I,J)=*,6(F10.6,2X))
 5690 FORMAT (20X,*THICKNESS OF PLANO CONVEX FOIL = *,F10.5,10X,*XM=*,
     1F10.5)
  565 FORMAT(20X,*R=*,F5.2,2X,*AAAA=*,F10.6,2X,*BBBB=*,F10.6,2X,*CCCC=*,
     XF10.6)
  566 FORMAT(20X,*A8=*,F10.6,2X,*B8=*,F10.6,2X,*C8=*,F10.6,2X,*D8=*,F10.
     X6)
  567 FORMAT(20X,*XROUND=*,F10.6,2X,*A2AA=*,F10.6,2X,*B2BB=*,F10.6,2X,*C
     X2CC=*,F10.6)
  795 FORMAT(8I10)
C AAAA,BBBB,CCCCARE CONSTANTS FOR 2-TERM CAMBER, X AND SQRT(X)
C  --------CALCULATED FROMANOTHER PROGRAM CALLED *CAMBER*----------.
C A8,B8,C8 AND D8 ARE COEFFICIENTS FOR POLYNOMIALS FOR X GREATER THAN ..
C CLOD AND CLODK ARE NO. DUMMY.
C SF4 IS USED FOR DETERMINING WHETHER TO CALCULATE BETA.
 1321 FORMAT(5E14.7)
C IFLAG=1 NEEDS DATA CARDS FOR SXSI(I). I=1,F, IREAD MAY BE SET TO 5.
C IF IFLAG=0 , DATA WILL BE READ EITHER FROM
C         DATA CARD, IF IREAD=5
C         TAPE1    , IF IREAD=1.
  551 FORMAT(10I8)
  201 FORMAT(4I8)
  202 FORMAT(4E14.7)
C DE,DG,DF ARE THE INCREMENTS FOR DERIVATIVES IN CXFMEN.
C DG=1.E-3 & DF=1.E-5 ARE USED BEFORE.
  229 FORMAT(3E14.7)
 1229 FORMAT(5X,4HLPM=,I4,2X,4HLPK=,I4,2X,6HSBETA=,E14.7,5X,6HIREAD=,I1,
     X2X,*NCHEY=*,I3)
 5651 FORMAT(20X,*BETAB AND BETAC AS FIRST GUESS=*,F10.5,2X,F10.5)
 1324 FORMAT(10X,3HDE=,E14.7,2X,3HDG=,E14.7,3HDF=,E14.7,2X,4HSF4=,E14.7)
 1521 FORMAT(10X,*SBETA2=*,E14.7)
      SBETA2=SBETA2*PAI/180.
      BETAB=BETAB*PAI/180.
      BETAC=BETAC*PAI/180.
C  LPMM=LPM2=NS2
      LPMM=LPM2
      NS2=LPM2
      LPMM1=LPMM+1
      WRITE(6,1499) LPM2,ISHARP
 1499 FORMAT(10X,*LPM2=*,I3,2X,*ISHARP=*,E14.7)
C ISHARP=0 FOR SHARP LE.
```

```
      PROGRAM PCASL(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE7,TAPE1)
C  NONLINEAR PARTIALLY CAVITATING CASCADE CALCULATIONS.
C  5/17/1978 PROGRAMMED BY O. FURUYA.
C
C
C----PROGRAM REVISED  FOR FIXED CAVITY LENGTH VERSION ON 9/15/78.
C
C
      DIMENSION YBE(6),XZ(6),BETAN0(513),BETAM0(513),BETA02(100)
      DIMENSION SXSI(6),XXX(513),CP(513)
      DIMENSION FL(200),FD(200),CP2(101),XXX2(201),FL2(100),FD2(100)
      COMMON/FOILEND/XXDD,YYDD
      COMMON /CVTYL/CAVLEN,BIGS2
      COMMON/FREECAV/XFREEC,YFREEC
      COMMON/DELTAD/DELT(6,6)
      COMMON/THICK/TH
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DSAP,ALFA1,GAMMA
      COMMON        SBETA,XXM,ICPI,SARCOD(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),      CLE,ERC,YYY,XM,ITERA,SXSIO(6),SXSI00(6),YYS(6)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XCX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
C BETAN-----FOR ARC 1  FOR REGULAR INTEGRAL.
C BBTAN IS FOR INTERPOLATED VERSION OF BETAN .
C BETAN2 FOR EQUALLY SPACED INCREMENT FOR ARC 2.
C BBTAN2 FOR CHEBYCHEV- GAUSS VERSION OF BETAN2.
      PAI=3.141592653
      READ(5,795) NGAUS
      NGAUS1=NGAUS+1
      NNN2=NGAUS/2
      NGAUS2=NNN2+1
      READ(5,560) (TGAUS(I),I=NGAUS2,NGAUS)
      READ(5,560) (WGAUS(I),I=NGAUS2,NGAUS)
      DO 26 IQ=1,NNN2
      TGAUS(IQ)=-TGAUS(NGAUS1-IQ)
   26 WGAUS(IQ)=WGAUS(NGAUS1-IQ)
      WRITE(6,561) (TGAUS(I),I=NGAUS2,NGAUS)
      WRITE(6,562) (WGAUS(I),I=NGAUS2,NGAUS)
  560 FORMAT(4F20.10)
  561 FORMAT(1X,*T(I)=*,10(F10.8,1X))
      READ (5,590) XXM


      DO 589 IDELTA=1,6
  589 READ (5,590) (DELT(IDELTA,I),I=1,6)
  562 FORMAT(1X,*W(I)=*,10(F10.8,1X))


C                                                        DDYY,DDXX,HT )065,5(DAEP
      READ(5,560) TH
      READ(5,560) R,AAAA,BBBB,CCCC
      READ(5,560) AB,BB,CB,DB
      READ(5,560) XROUND,A2AA,B2BB,C2CC
      READ(5,795)          NCHBY
```

```
C        1 FOR ROUNDED L.E.
      SBETA=SBETA*PAI/180.
      DO 999 IJKL=1,NITER
C FFF4 IS PROVIDED FROM DXFNEW, BUT IF THE LOOP DOES NOT GO THROUGH
C     IT, FFF4 OF PRESET VALUE MUST BE USED.
      FFF4=0.
      ALFA1D=ALFA1S
      GAMMAD=GAMMAS
      SOLID=SOLIS
      IF(NHK.EQ.1) GO TO 240
      IF(NHK.EQ.2) GO TO 241
      SOLID=SOLIS+0.1*FLOAT(IJKL-1)
      GO TO 243
  241 GAMMAD=GAMMAS+2.*FLOAT(IJKL-1)
      GO TO 243
  240 ALFA1D=ALFA1S-2.*FLOAT(IJKL-1)
  243 CONTINUE
      XM=AXM
      ALFA1=ALFA1D*PAI/180.
      DGAP=1./SOLID
      GAMMA=GAMMAD*PAI/180.
      DELTA=ALFA1+GAMMA
      FLAPAN=0.
      WRITE(6,666) ALFA1D,GAMMAD,SOLID
  666 FORMAT(1X,16HINCIDENCE ANGLE=,E14.7,1X,6HGAMMA=,E14.7,1X,9HSOLIDIT
     XY=,E14.7)
      WRITE(6,663) FLAPAN
  663 FORMAT(5X,11HFLAP ANGLE=,E14.7)
      STOLL=2.E-4
      STOLS=5.E-4
      ERC=1.E-2
      CLE=1.E-4
      WRITE(6,511) CAVLEN
  511 FORMAT(10X,*CAVITY LENGTH=*,E14.7)
C SPECIFY HYDROFOIL*S CHARACTERISTICS AND SEP. POINTS.
      XC=0.
      YC=0.
      XB=0.
      XA=1.
      WRITE(6,502)XA,XB,XC,YC,XXDD,YYDD
  502 FORMAT(10X,6HCHORD=,E14.7,2X,17HUPPER SEP. POINT=,E14.7,2X,20HCONV
     X. POINT(XC,YC)=(,E14.7,1H,,E14.7,1H)/*  XXDD=*,F10.6,2X,*YYDD=*,
     Y F10.6)
C START ITERATIVE PROCEDURE.
C     -----BASIC FLO. IS THAT OF FLAT PLATE-----.
C ITERAT IS INDEX FOR NUMBER OF ITERATIONS.
      ITERA=1
      IF(IFLAG.EQ.0) ITERA=2
      IF(IFLAG.EQ.0) IREAD=1
      BIGS=0.
      XHIGH=0.
      XLOW=0.
      IS1I2=0
      XINCRT=XA/50.
      DO 248 IINC=1,50
      XLOW=XHIGH
      XHIGH=XLOW+XINCRT
      CALL ARCLEN(S,XLOW,XHIGH,IS1I2)
  248 BIGS=BIGS+S
C ----FIND BIGS2-----
```

```
C          FIRST CALL SHAPE TO FIND A CORRESPONDING TO CAVLEN.
      XCCC=0.
      YCCC=0.
      CALL SHAPE(CAVLEN,Y,BETA,1)
      CALL ARCS2(BIGS2,CAV_EN,Y)
      WRITE(6,504) BIGS,BIGS2
  504 FORMAT(10X,5HBIGS=,E14.7,5X,*BIGS2=*,E14.7)
      STOL=1.E-5
      LPM=LPMS
      LPK=LPKS
      LPM1=LPM-1
      LPM3=LPM-3
C ICPI IS USED FOR CONTROLLING PROGRAM; 0 FOR ITER. 1 FOR THE REST.
C FIND XSIB,XSIC,XSIF,A,ALFA2 BY USING NEWTON,S METHOD.
C SXSI(1)=XSIB
C SXSI(2)=XSIC
C SXSI(3)=XSIF
C SXSI(4)=A WHICH IS THE COEFFT. OF MAPPING FCN.
C SXSI(5)=ALF2
C SXSI(6)=SIGMA
      IF(IJKL.GE.2) GO TO 630
      IF(IFLAG.EQ.0) GO TO 779
C INATIAL GUESS FOR SXSI(I) IS ----------
      READ(5,768) SXSI(1),SXSI(2),SXSI(3),SXSI(4),SXSI(5),SXSI(6)
      GO TO 160
  779 READ(IREAD,620) SXSI(1),SXSI(2),SXSI(3),SXSI(4),SXSI(5),SXSI(6)
  620 FORMAT(6E13.7)
  629 DO 621 IC=1,LPM
  621 READ(IREAD,622) SARC(IC),BETAN(IC)
  622 FORMAT(2E14.7)
      DO 1621 IC=1,LPMM1
 1621 READ(IREAD,622) SARC2(IC),BETAN2(IC)
      IF(IFLAG.EQ.0) GO TO 480
      GO TO 481
  480 DO 482 IBT=1,LPM1
  482 BETAM(IBT)=.5*(BETAN(IBT)+BETAN(IBT+1))
  481 CONTINUE
  160 ICPI=0
      WRITE(6,102) ITERA
  102 FORMAT(10X,14HITERATION NO.=,I2)
      DO 650 IRP=1,6
  650 SXSIC(IRP)=SXSI(IRP)
      IF(ITERA.GE.2) STOL=STOLS
      IF(ITERA.EQ.MSTOP) STOL=STOLL
C
C
C
C
      CALL SXFNEW(SXSI,STOL,MAXIT,ITN,DG,DF,FFF4)
C
C
C
C
  630 CONTINUE
      DO 537 IC1=1,6
      XSN(IC1)=SXSI(IC1)
  537 WRITE(6,536) IC1,SXSI(IC1)
  536 FORMAT(10X,5HSXSI(,I1,2H)=,E14.7)
      CSPACE=(1.+SXSI(1))/FLOAT(LPK)
      HCSPAC=0.5*CSPACE
```

```
      FSPACE=CSPACE/FLOAT(LPM-LPK)
      HFSPAC=0.5*FSPACE
      XSET=-1.+CSPACE*FLOAT(LPK-1)
      ICPI=1
C ICPI=0 FOR FINDING SXSI(I), I.E., SXSI(I)=YXS(1)≥ ICPI=1 FOR THE REST.
C CALCULATION OF PRESSURE DISTRIBUTION FOR.
      IF(ITERA.EQ.1) GO TO 36
      DO 35 IB=1,LPM
   35 BETAN0(IB)=BETAN(IB)
      DO 37 IB=1,LPM1
   37 BETAM0(IB)=BETAM(IB)
      DO 355 IB=1,LPMM1
  355 BETA02(IB) = BETAN2(IB)
   36 CONTINUE
C                              ECAPSE/)AMMAG+)5(ISXS(SOC/)AMMAG+1AFLA(SOC=200
      UU2=COS(ALFA1+GAMMA)/COS(SXSI(5)+GAMMA)                                  C
      UU22=UU2**2
      DO 25 LG=1,LPM
      LP=LG
C FIND CP(XSIP) NEXT.
C----- FOR THE FIRST WETTED ARC PORTION S1-----
C     CP IS BASED  ON U1 AND P1.
C     LP=1 IS NEAR THE T.E.
C     LP=LPM IS NEAR THE L.E.
      IF(LP.EQ.1)  GO TO 521
      IF(LP.EQ.LPM) GO TO 52
      G2=EXP(XITN(LP))
C XITN(I) IS CALCULATED IN OFSIM2 OF OXFNEW FOR F(4).
      G2=G2**2
      CP(LP)=1.-UU22*G2
      GO TO 522
   52 CP(LP)=-SXSI(6)
      GO TO 522
  521 CP(LP)=1.-UU22
  522 CONTINUE
   25 CONTINUE
C                                                          EUNITNOC 431
C                                                         .(=)MPL(PC
C                                                )3,021X,PCY,PCX(NEXTIA=)1-MPL(PC
C                                                )3,911X,PCY,PCX(NEXTIA=)2-MPL(PC
C                                                     ECAPSF-)1('SXS=021X
C                                                ECAPSF*.2-)1('SXS=911X
C                                                         .C=)4(PCY
C                                                    )?-MPL(PC=)3(PCY
C                                                    )5-MPL(PC=)2(PCY
C                                                    )7-MPL(PC=)1(PCY
C                                                      )1(ISXS=)4(PCX
C                                                 ECAPSF*.2+)2(PCX=)3(PCX
C                                                 ECAPSF*.2+)1(PCX=)2(PCX
C                                               ECAPSF*.7-)1(ISXS=)1(PCX
C                                               431 OT CG )1.GE.ARETI(FI
C
C
C*********MAIN INSERT 1*************************************************
C                                                                       *
C                                                                       *
C------CP FOR THE SECOND ARC S2-------
C       NUMBER OF CONTROL POINTS ON S2 IS FIXED
C       IN SUBROUTINE OFSIM5, I.E.,
C          HALF OF THE POINT USED FOR BETA
```

```
C         ANSG2S IN COMMON = G2.
      DO 680 NCP = 1,LPMM1
      IF(NCP.EQ.1) GO TO 681
      IF (NCP.EQ.LPMM1) GO TO 682
      G2 = EXP(ANSG2S(NCP))
      G2 = G2**2
      CP2(NCP) = 1.-G2*UU22
      GO TO 680
  681 CP2(NCP)=-SXSI(6)
      GO TO 680
  682 CP2(NCP) = 1.-UU22
  680 CONTINUE
C                                                                              *
C                                                                              *
C*********MAIN INSERT 1*************************************************************
C
C
      AF4=ABS(FFF4)
      IF(AF4.GE.SF4) GO TO 1135
      GO TO 1134
 1135 WRITE(6,1136)
 1136 FORMAT(5X,*F(4) IS TOO LARGE TO CALCULATE BETA*)
      STOP
C FIND XXX(XSIP) FIRST.
 1134 CONTINUE
      IS1S2=0
C-----FIRST BETA FOR ARC 1-----.
      DO 100 LLP=1,LPM
      LP=LPM-LLP+1
      CALL BBBETA(XYX,BETA,IS1S2)
      XXX(LP)=XYX
      BETAN(LP)=BETA
      IF(LP.EQ.LPM) BETAB=BETA
      IF(ITERA.LE.MSTOP1) GO TO 100
      WRITE(6,101) LP,SARC(LP),XXX(LP),CP(LP),BETAN(LP)
  100 CONTINUE
  101 FORMAT(1X,2HI=,I3,1X,5HSARC=,E14.7,1X,4HXXX=,E14.7,1X,3HCP=,E14.7,
     X1X,6HBETAN=,E14.7)
C
C
C*********MAIN INSERT 2*************************************************************
C                                                                              *
C                                                                              *
C----------BETA FOR ARC S2------------------------.
C             SARC2 HAS BEEN CALCULATED
C             IN SUBROUTINE OFSIMS AND
C             STORED IN COMMON AREA.
      IS1S2 = 1
      DO 429 LLP=1,LPMM1
      LP=LLP
      CALL BBBETA(XYX,BETA,IS1S2)
      IF(LP.EQ.1) BETAC=BETA
      XXX2(LP) = XYX
      BETAN2(LP) = BETA
      IF(ITERA.LE.MSTOP1) GO TO 329
      WRITE(6,239) LP,SARC2(LP),XXX2(LP),CP2(LP),BETAN2(LP)
  239 FORMAT(5X,*I=*,I3,1X,*SARC2=*,E14.7,1X,*XXX2=*,
     *E14.7,1X,*CP2=*,E14.7,1X,*BETAN2=*,E14.7)
  329 CONTINUE
  429 CONTINUE
```

```
C                                                                       *
C                                                                       *
C*********MAIN INSERT 2*****************************************************
C
C
C*********MAIN INSERT 3 *****************************************************
C                                                                       *
C                                                                       *
C FIND LIFT AND DRAG.
C----------FIRST CL AND CD FOR S1 PART.
      USID = SIN(DELTA)
      UCOD = COS(DELTA)
      UXB = SXSI(4)*UCOD
      UXB2 = UXB**2
      DO 105 ITK = 1,LPM
      IF(ITK.GT.LPK) GO TO 106
      XPS = -1.*CSPACE*FLOAT(ITK-1)
      GO TO 108
  106 XPS = XBET+FSPACE*FLOAT(ITK-LPK)
  108 CONTINUE
      UXA = XPS-SXSI(4)*USID
      UXA2 = UXA**2
      PXXP = UCOD/(UXA2+UXB2)
      DWDX = DGAP*PXXP*XPS/PAI
      COBET1      = COS(BETAN(ITK))
      SIBET1      = SIN(BETAN(ITK))
      DS1DX = -EXP(-XITN(ITK))*DWDX/UU22
C     S1 IS CALCULATED AT OFSIM2 AS XITN(I).
C     AND STORED IN COMMON.
      IF(XPS.LT.0.) DS1DX = -DS1DX
      XLP1 = DS1DX*CP(ITK)
      FL(ITK) = -XLP1*COBET1
      FD(ITK) = XLP1*SIBET1
  105 CONTINUE
C-----CL AND CD FOR S2 PART.
      NS21=NS2+1
      NS2A=NS2-1
      GAP2 = (SXSI(3)-SXSI(2))/NS2
      DO 338 ITK = 1, NS21
      XRS2 = SXSI(2)+GAP2*(ITK-1)
      UXA = XRS2-SXSI(4)*USID
      UXA2 = UXA**2
      PXXP = UCOD/(UXA2+UXBC)
      DWDX = DGAP*PXXP*XRS2/PAI
      COBET2 =-COS(BETAN2(ITK))
      SIBET2 =-SIN(BETAN2(ITK))
      DS2DX = EXP(-ANSG2S(ITK))*DWDX/UU22
C     G2 IS ALREADY CALCULATED AT OFSIM3 AS
C     ANSG2S(I), STORED IN COMMON AREA.
      XLP2 =  DS2DX*CP2(ITK)
      FL2(ITK) =-XLP2*COBET2
      FD2(ITK) =  XLP2*SIBET2
  338 CONTINUE
      SPACE = CSPACE
      CLIFT = 0.5*CSPACE*FL(2)+0.5*FSPACE*FL(LPM1)
      CDRAG = 0.5*CSPACE*FD(2)+0.5*FSPACE*FD(LPM1)
      DO 111 IUA = 2,LPM3,2
      IF(IUA.GE.LPK) SPACE = FSPACE
      CLIFT = CLIFT+SPACE*(FL(IUA)+4.*FL(IUA+1)+FL(IUA+2))/3.
  111 CDRAG = CDRAG+SPACE*(FD(IUA)+4.*FD(IUA+1)+FD(IUA+2))/3.
```

```
      DO 321 IUA = 1,NS2A,2
      CLIFT = CLIFT+GAP2*(FL2(IUA)+4.*FL2(IUA+1)+FL2(IUA+2))/3.
  321 CDRAG = CDRAG+GAP2*(FD2(IUA)+4.*FD2(IUA+1)+FD2(IUA+2))/3.
C-----ADD THE FORCES ON CAVITY PORTIONS.
C     SUBROUTINE XCYC CALCULATES
C   THE POINT ON THE UPPER BLADE PORTION CORRESP. TO THE CAVITY END POINT.
      CXA=XCCC
      CYA=YCCC
      CALL XCYC(XCCCB,YCCCB,CXA,CYA)
      CLIFT = CLIFT+SXSI(6)*XCCCB
      CDRAG = CDRAG-SXSI(6)*YCCCB
C-----XCCC AND YCCC ARE THE END POINTS OF CAVITY, CALCULATED IN
C     SUBROUTINE CAVITY
C     STORED IN COMMON.
C
C                                                                              .
C                                                                              .
C**********MAIN INSERT 3 ***************************************************
C
C
C FIND BINF IN Z-1.
      U2U1=COS(ALFA1+GAMMA)/COS(SXSI(5)+GAMMA)
      DOWN=COS(ALFA1+GAMMA)*COS(SXSI(5)+GAMMA)
      BINF=0.5*SIN(ALFA1+SXSI(5)+2.*GAMMA)/DOWN
      BINF=ATAN(1./BINF)
      AINF=0.5*PAI-BINF-GAMMA
C CDSTAR AND CLSTAR ARE BASED ON VELOCITY AT UPSTREAM INFINITY IN (X,Y).
      CDSTAR=CDRAG
      CLSTAR=CLIFT
      UINF=0.5*SQRT(1.+U2U1**2+2.*U2U1*COS(ALFA1-SXSI(5)))
      FINF=2.*DGAP*SIN(ALFA1-SXSI(5))/(UINF*COS(SXSI(5)+GAMMA))
      CLINF=CLSTAR*COS(AINF)-CDSTAR*SIN(AINF)
      CDINF=CLSTAR*SIN(AINF)+CDSTAR*COS(AINF)
      CLINF=CLINF/UINF**2
      CDINF=CDINF/UINF**2
      WRITE(6,117) CLINF,CDINF
  117 FORMAT(1X,34HCLINF OR CDINF=FORCE/1/2RO.UINF**2,5X,6HCLINF=,E14.7,
     X1X,6HCDINF=,E14.7)
      WRITE(6,118) FINF
  118 FORMAT(1X,34HFINF IS OBTAINED FROM MOMENTUM EQN,5HFINF=,E14.7)
      WRITE(6,221)
  221 FORMAT(1X,48H---CDLL & CDDD ARE BASED ON U1 IN ALFA1 DIRE.---)
      CDLL=CLSTAR*COS(ALFA1)-CDSTAR*SIN(ALFA1)
      CDDD=CLSTAR*SIN(ALFA1)+CDSTAR*COS(ALFA1)
      ALOD=CDLL/CDDD
      WRITE(6,191) CDDD,CDLL,ALOD
  191 FORMAT(1X,5HCDDD=,E14.7,1X,5HCDLL=,E14.7,1X,4HL/D=,E14.7)
      MSTOP1=MSTOP-1
      IF(ITERA.LE.MSTOP1) GO TO 140
C
C
C**********MAIN INSERT 4 ***************************************************
C                                                                              .
C                                                                              .
C     CAVITY SHAPE.
C        ALREADY CALCULATED IN
C        SUBROUTINE CAVITY.
      WRITE(6,287)
  287 FORMAT(2X,*---CAVITY SHAPE------*)
      NCAV1=NCAV+1
      DO 285 KCAV=1,NCAV1,2
```

```
  255 WRITE(6,256) CAVX(KCAV ),CAVY(KCAV )
  256 FORMAT(10X,*X=*,E14.7,10X,*Y=*,E14.7)
C                                                                              *
C                                                                              *
C**********MAIN INSERT 4 ***************************************************
C
C
  140 CONTINUE
      XCCC=0.
      YCCC=0.
      WRITE(6,823)
  823 FORMAT(//,*------------UPPER BODY SHAPE----------*)
      DO 821 ISHP=1,51
      X=.02*(ISHP-1)
      CALL SHAPE (X,Y,BETA,1)
  821 WRITE(6,822) X,Y
  822 FORMAT(5X,*X=*,F10.5,2X,*Y=*,F10.5)
      REWIND 7
      WRITE(7,766) SXSI(1),SXSI(2),SXSI(3),SXSI(4),SXSI(5),SYSI(6)
  766 FORMAT(6E13.7)
      DO 766 IC=1,LPM
  766 WRITE(7,767) SARC(IC),BETAN(IC)
  767 FORMAT(2E14.7)
      DO 1766 IC=1,LPMM1
 1766 WRITE(7,767) SARC2(IC),BETAN2(IC)
      IF(ITERA.GE.MSTOP) GO TO 999
      LPK1=LPK-1
      SPACE=CSPACE
      HSPACE=HCSPAC
      DO 50 IM=1,LPM1
      IF(IM.EQ.1) GO TO 51
      IF(IM.EQ.LPM1) GO TO 55
      IF(IM.EQ.LPK1) GO TO 97
      IF(IM.EQ.LPK) GO TO 98
      IF(IM.GT.LPK) GO TO 93
      XY=-1.+SPACE*FLOAT(IM-1)+HSPACE
      XZ(1)=-1.+SPACE*FLOAT(IM-2)
      XZ(2)=XZ(1)+SPACE
      XZ(3)=XZ(2)+SPACE
      XZ(4)=XZ(3)+SPACE
      GO TO 99
   93 SPACE=FSPACE
      HSPACE=HFSPAC
      XY=XBET+HSPACE+ SPACE*FLOAT(IM-LPK)
      XZ(1)=XBET+SPACE*FLOAT(IM-LPK-1)
      XZ(2)=XZ(1)+SPACE
      XZ(3)=XZ(2)+SPACE
      XZ(4)=XZ(3)+SPACE
   99 DO 56 IK=1,4
   56 YBE(IK)=BETAN(IM+IK-2)
      BETAM(IM)=AITKEN(XZ,YBE,XY,3)
      GO TO 151
   97 BETAM(LPK1)=0.5*(BETAN(LPK1)+BETAN(LPK))
      GO TO 151
   98 BETAM(LPK)=0.5*(BETAN(LPK)+BETAN(LPK+1))
      GO TO 151
   51 BETAM(1)=0.5*(BETAN(1)+BETAN(2))
      GO TO 151
   55 BETAM(LPM1)=0.5*(BETAN(LPM1)+BETAN(LPM))
  151 CONTINUE
```

```
   50 CONTINUE
      IF(ITERA.EQ.1) GO TO 6
      DO 41 IE=1,LPM
   41 BETAN(IE)=BETAN(IE)*(1.-XXM)+BETAN0(IE)*XXM
      DO 42 IFG=1,LPM1
   42 BETAM(IFG)=BETAM(IFG)*(1.-XXM)+BETAM0(IFG)*XXM
      DO 425 IFG=1,LPMM1
  425  BETAN2(IFG) = BETAN2(IFG)*(1.-XXM)+BETA02(IFG)*XXM
      DO 652 IRP=1,5
  652 SXSI(IRP)=SXSI(IRP)*(1.-XXM)+SXSI0(IRP)*XXM
    6 ITERA=ITERA+1
      IF(ITERA.GT.MSTOP) GO TO 26
      GO TO 100
   26 WRITE(6,29)
   29 FORMAT(5X,26HITERATION WAS TERMAINATED.)
  999 CONTINUE
      STOP
      END
vv
```

```
      SUBROUTINE OXFRE*(X,STOL,M,I,DG,DE,FFF4)
      DIMENSION F(6),P(50,6),X(6),Q(6,6),XRRI(5),XMMI(5)
      COMMON/DELTAD/DELT(6,6)
      COMMON /CVTYL/CAVLEV,BIGS2
      COMMON/FREECAV/XFREEC,YFREEC
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LEMM,MS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON       SBETA,XXM,ICPI,SARCCD(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),     CLE,ERC,YYY,XM,ITERA,SXSIC(6),SXSICD(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A5,B5,C5,D5,TGAUS(100),WGAUS(100),NGAUS
      PAI=3.141592653
      I=0
      IF(ITERA.LE.3) GO TO 272
      DO 67 IIJ=1,6
   67 WRITE(6,66) IIJ,X(IIJ)
   66 FORMAT(1X,24HX(,I1,24H)=,E14.7)
  272 CONTINUE
   55 SI1=2.*DE
      SI6=2.*DG
      IF(X(1).LT.SI1) X(1)=SI1
      SI10=X(1)+2.*DG
      IF(X(2).LT.SI10) X(2)=SI10
      SI11=X(2)+2.*DG
      IF(X(3).LT.SI11) X(3)=SI11
      IF(X(4).LT.SI6) X(4)=SI6
      SI5=(0.5*PAI-GAMMA)*(1.-0.02)
      IF(X(5).LT.0.) GO TO 78
      IF(X(5).GT.SI5) X(5)=SI5
      GO TO 79
   78 IF(ABS(X(5)).GT.SI5) X(5)=-SI5
   79 CONTINUE
      IF(X(6).LE..001) X(6)=.001
      DO 66 IIJ=1,6
   66 WRITE(6,66) IIJ,X(IIJ)
      IJ=1
C------F(1)-----------------------------------------------------------------
      DO 20 IK=1,6
   20 YXS(IK)=X(IK)
    5 CONTINUE
      KCTRL = 1
      CALL F1INTL(YINT1,KCTRL)
C     SUBROUTINE F1INTL CALCULATES THE INTEGRALS IN F(1).
      KCTRL = 2
      CALL F1INTL (YINT2,KCTRL)
      KCTRL = 3
      CALL F1INTL (YINT3,KCTRL)
      KCTRL = 4
      CALL F1INTL (YINT4,KCTRL)
      CCC1=ALOG(1.+YXS(6))/(2.*PAI)
C                     )ECAPSE/)AMMAG+1AFLA(SCC/)AMMAG+)F(SXY(SCC(GOLA=1SC
      CS1 = ALOG(COS(YXS(5)+GAMMA)/COS(ALFA1+GAMMA))
      FA = -(YINT1/PAI+YINT2-(CCC1+CS1/PAI)*YINT3
```

```
     1+YINT4/PAI-YXS(5))
       IF (IJ.EQ.1) WRITE (6,70) YINT1,YINT2,YINT3,YINT4
    70 FORMAT (10X,*---I1,I2,I3,I4 OF F(1) ARE---*,4(E14.7,2X))
       IF (IJ.EQ.1) F(1) = FA
       IF (IJ.EQ.2) GO TO 3
       IF (IJ.EQ.3) GO TO 4
       IF (IJ.EQ.4) GO TO 320
       IF (IJ.EQ.5) GO TO 321
       IF (IJ.EQ.6) GO TO 322
       IF(IJ.EQ.66) GO TO 3222
       P(1,5) = TAN(YXS(5)+GAMMA)*YINT3/PAI-1.
       P(1,6)=-YINT3/(2.*PAI*(1.+YXS(6)))
       IJ = 2
       YXS(1) = X(1)+DELT(1,1)
       GO TO 5
     3 F1P = -FA
       IJ = 3
       YXS(1) = X(1)-DELT(1,1)
       GO TO 5
     4 F1Q = -FA
       P(1,1) = (F1P-F1Q)/(2.*DELT(1,1))
       IJ = 4
       YXS(1) = X(1)
       YXS(2) = X(2)+DELT(1,2)
       GO TO 5
   320 F1P = -FA
       YXS(2) = X(2)-DELT(1,2)
       IJ = 5
       GO TO 5
   321 F1Q = -FA
       P(1,2) = (F1P-F1Q)/(2.*DELT(1,2))
       YXS(2) = X(2)
       YXS(3) = X(3)+DELT(1,3)
       IJ = 6
       GO TO 5
   322 F1P = -FA
       IJ=66
       YXS(3)=X(3)-DELT(1,3)
       GO TO 5
  3222 F1Q=-FA
       YXS(3)=X(3)
       P(1,3) = (F1P-F1Q)/(2.*DELT(1,3))
       P(1,4) = 0.
C------F(2) AND F(3)-----------------------------------------------------------
       IJ = 7
   330 CONTINUE
C                        )ECAPSE/)AMMAG+)5(SXY(SOC/)AMMAG+1AFLA(SOC((OLA=XKKX
       XKKX = ALOG(COS(ALFA1+GAMMA)/COS(YXS(5)+GAMMA))                          C
       XX1  = YXS(4)*SIN(DELTA)
       YY1  = YXS(4)*COS(DE_TA)
       YY12=YY1**2
       CCC1=ALOG(1.+YXS(6))/(2.*PAI)
       CON1 = CCC1-XKKX/PAI
       XRP = 0.
       XMM = 0.
       DO 331 MIQ = 1,4
       CALL RMINT(SOLNR,SOLNM,MIQ)
       XRRI(MIQ) = SOLNP
       XMMI (MIQ) = SOLNM
       XRRR = -XRRI(MIQ)/PAI
```

```
      XMMM = -XMMI(MIQ)/PAI
      IF (MIQ.EQ.1) XRRR = CON1*XRRI(MIQ)
      IF (MIQ.EQ.1) XMMM = CON1*XMMI(MIQ)
      IF (MIQ.EQ.4) XRRR = -XRRI(MIQ)
      IF (MIQ.EQ.4) XMMM = -XMMI(MIQ)
      IF (IJ.EQ.7) WRITE (6,71) (XRRI(I),I=1,4)
      IF (IJ.EQ.7) WRITE (6,72) (XMMI(I),I=1,4)
   71 FORMAT(10X,*---XRRI(I),I=1,4 OF F(2) AND F(3) ARE---*,4(E14.7,2X))
   72 FORMAT(10X,*---XMMI(I),I=1,4 OF F(2) AND F(3) ARE---*,4(E14.7,2X))
      XRR = XRR+XRRR
      XMM = XMM+XMMM
  331 CONTINUE
C-----CALCULATION OF H1(ZETA1)-------.
      XSIP1 = XX1+1.
      XSIMB = XX1-YXS(1)
      XSIMF = XX1-YXS(3)
      XSIMC = XX1-YXS(2)
      XSIP12 = XSIP1**2
      XSIMB2 = XSIMB**2
      XSIMF2 = XSIMF**2
      XSIMC2 = XSIMC**2
      RRA = SQRT(XSIP12+YY12)
      RRB = SQRT(XSIMB2+YY12)
      RRC = SQRT(XSIMF2+YY12)
      RRD = SQRT(XSIMC2+YY12)
      THIA = ATAN(YY1/XSIP1)
      IF (XSIP1.LE.0.) THIA = PAI+THIA
      THIB = ATAN(YY1/XSIMB)
      IF (XSIMB.LE.0.) THIB = PAI+THIB
      THIC = ATAN(YY1/XSIMF)
      IF (XSIMF.LE.0.) THIC = PAI+THIC
      THID = ATAN(YY1/XSIMC)
      IF (XSIMC.LE.0.) THID = PAI+THID
      RR1 = SQRT(RRA*RRB*RRC/RRD)
      THIT1 = .5*(THIA+THIB+THIC-THID)
      COTH1 = COS(THIT1)
      SITH1 = SIN(THIT1)
      F2CO = RR1*(XRR*COTH1-XMM*SITH1)-ALFA1
      F3CO = RR1*(XRR*SITH1+XMM*COTH1)+XXXX
      IF (IJ.EQ.7) F(2) = -F2CO
      IF (IJ.EQ.7) F(3) = -F3CO
      IF (IJ.EQ.8) GO TO 340
      IF (IJ.EQ.9) GO TO 341
      IF (IJ.EQ.10) GO TO 342
      IF (IJ.EQ.11) GO TO 343
      IF (IJ.EQ.12) GO TO 344
      IF (IJ.EQ.13) GO TO 345
      IF (IJ.EQ.14) GO TO 346
      IF (IJ.EQ.15) GO TO 347
      TA2G =  TAN(YXS(5)+GAMMA)
      P(2,5) = -RR1*TA2G*(XRRI(1)*COTH1-XMMI(1)*SITH1)
      P(2,5) = P(2,5)/PAI
      P(3,5) = -RR1*TA2G*(XRRI(1)*SITH1+XMMI(1)*COTH1)
      P(3,5) = P(3,5)/PAI+TA2G
      BPY=2.*PAI*(1.+YXS(5))
      P(2,6)=RR1*(XRRI(1)*COTH1-XMMI(1)*SITH1)/BPY
      P(3,6)=RR1*(XRRI(1)*SITH1+XMMI(1)*COTH1)/BPY
      IJ = 8
      YXS(1) = X(1)+DELT(1,2)
      GO TO 330
```

```
  340 FP2 = F2CO
      FP3 = F3CO
      IJ = 9
      YXS(1) = X(1)-DELT(2,1)
      GO TO 330
  341 P(2,1) = (FP2-F2CO)/(2.*DELT(2,1))
      P(3,1) = (FP3-F3CO)/(2.*DELT(2,1))
      YXS(1) = X(1)
      YXS(2) = X(2)+DELT(2,2)
      IJ = 10
      GO TO 330
  342 FP2 = F2CO
      FP3 = F3CO
      YXS(2) = X(2)-DELT(2,2)
      IJ=11
      GO TO 330
  343 P(2,2) = (FP2-F2CO)/(2.*DELT(2,2))
      P(3,2) = (FP3-F3CO)/(2.*DELT(2,2))
      YXS(2) = X(2)
      YXS(3) =   X(3)+DELT(2,3)
      IJ = 12
      GO TO 330
  344 FP2 = F2CO
      FP3 = F3CO
      YXS(3) = X(3)-DELT(2,3)
      IJ = 13
      GO TO 330
  345 P(2,3) = (FP2-F2CO)/(2.*DELT(2,3))
      P(3,3) = (FP3-F3CO)/(2.*DELT(2,3))
      YXS(4) = X(4)+DELT(2,4)
      YXS(3)=X(3)
      IJ=14
      GO TO 330
  346 FP2=F2CO
      FP3=F3CO
      YXS(4) = X(4)-DELT(2,4)
      IJ = 15
      GO TO 330
  347 P(2,4) = (FP2-F2CO)/(2.*DELT(2,4))
      P(3,4) = (FP3-F3CO)/(2.*DELT(2,4))
      YXS(4)=X(4)
C------F(4)-----------------------------------------------------------------
      IJ=16
      YXS(1)=X(1)+DELT(4,1)
  199 CALL OFSIM2(ANS2)
      IF(IJ.EQ.16) GO TO 613
      IF(IJ.EQ.17) GO TO 614
      IF(IJ.EQ.18) GO TO 675
      IF(IJ.EQ.19) GO TO 615
      IF(IJ.EQ.20) GO TO 616
      IF(IJ.EQ.21) GO TO 617
      IF(IJ.EQ.22) GO TO 618
      IF(IJ.EQ.23) GO TO 621
      IF(IJ.EQ.24) GO TO 622
      IF(IJ.EQ.25) GO TO 623
      IF(IJ.EQ.26) GO TO 624
      IF(IJ.EQ.261) GO TO 6241
      IF(IJ.EQ.262) GO TO 6242
  613 ANSP=ANS2
      IJ=17
```

```
      YXS(1)=X(1)-DELT(4,1)
      GO TO 199
  614 ANSG=ANS2
      IJ=18
      P(4,1)=-(ANSP-ANSG)/(2.*DELT(4,1))
      YXS(1)=X(1)
      GO TO 199
  675 ANSF=ANS2
      F(4)=-(BIGS-ANSF)
      IJ=19
      YXS(2)=X(2)+DELT(4,2)*ABS(X(2))
      GO TO 199
  615 ANSPP=ANS2
      IJ=20
      YXS(2)=X(2)-DELT(4,2)*ABS(X(2))
      GO TO 199
  616 ANSGG=ANS2
      P(4,2)=-(ANSPP-ANSGG)/(2.*DELT(4,2)*ABS(X(2)))
      YXS(2)=X(2)
      IJ=21
      YXS(3)=X(3)+DELT(4,3)*X(3)
      GO TO 199
  617 ANS1P=ANS2
      IJ=22
      YXS(3)=X(3)-DELT(4,3)*X(3)
      GO TO 199
  618 ANS1G=ANS2
      P(4,3)=-(ANS1P-ANS1G)/(2.*DELT(4,3)*X(3))
      YXS(3)=X(3)
      IJ=23
      YXS(4)=X(4)+DELT(4,4)*ABS(X(4))
      GO TO 199
  621 ANA=ANS2
      IJ=24
      YXS(4)=X(4)-DELT(4,4)*ABS(X(4))
      GO TO 199
  622 ANB=ANS2
      P(4,4)=-(ANA-ANB)/(2.*DELT(4,4)*ABS(X(4)))
      YXS(4)=X(4)
      IJ=25
      YXS(5)=X(5)+DELT(4,5)
      GO TO 199
  623 BNA=ANS2
      IJ=26
      YXS(5)=X(5)-DELT(4,5)
      GO TO 199
  624 BNB=ANS2
      P(4,5)=-(BNA-BNB)/(2.*DELT(4,5))
      YXS(5)=X(5)
      FFF4=F(4)
      YXS(5) = X(5)
      YXS(6)=X(6)+DELT(4,6)
      IJ=261
      GO TO 199
 6241 BNA=ANS2
      IJ=262
      YXS(6)=X(6)-DELT(4,6)
      GO TO 199
 6242 BNB=ANS2
      P(4,6)=-(BNA-BNB)/(2.*DELT(4,6))
```

```
      YXS(6)=X(6)
C------F(5)----------
C   THIS SUBROUTINE FINDS THE END POINT OF CAVITY.
      IJ = 27
  815 CALL CAVITY (XCEND,YCEND)
      IF(IJ.EQ.27) GO TO 820
      IF(IJ.EQ.28) GO TO 821
      IF (IJ.EQ.29) GO TO 822
      IF (IJ.EQ.30) GO TO 823
      IF (IJ.EQ.31) GO TO 824
      IF (IJ.EQ.32) GO TO 825
      IF (IJ.EQ.33) GO TO 826
      IF (IJ.EQ.34) GO TO 827
      IF(IJ.EQ.341) GO TO 830
      IF (IJ.EQ.35) GO TO 828
      IF (IJ.EQ.36) GO TO 829
      IF(IJ.EQ.37) GO TO 840
      IF(IJ.EQ.38) GO TO 841
  820 F(5)=-(XCEND-CAVLEN)
      IJ = 28
      YXS(1) = X(1)+DELT(5,1)
      GO TO 815
  821 ANP=XCEND
      IJ = 29
      YXS(1) = X(1)-DELT(5,1)
      GO TO 815
  822 P(5,1)=(ANP-XCEND)/(2.*DELT(5,1))
      YXS(1) = X(1)
      YXS(2) = X(2)+DELT(5,2)*ABS(X(2))
      IJ = 30
      GO TO 815
  823 ANP=XCEND
      YXS(2) = X(2)-DELT(5,2)*ABS(X(2))
      IJ = 31
      GO TO 815
  824 P(5,2)=(ANP-XCEND)/(2.*DELT(5,2)*ABS(X(2)))
      YXS(2) = X(2)
      IJ = 32
      YXS(3) = X(3)+DELT(5,3)*X(3)
      GO TO 815
  825 ANP=XCEND
      YXS(3) = X(3)-DELT(5,3)*X(3)
      IJ = 33
      GO TO 815
  826 P(5,3)=(ANP-XCEND)/(2.*DELT(5,3)*X(3))
      IJ = 34
      YXS(3) = X(3)
      YXS(4) = X(4)+DELT(5,4)*ABS(X(4))
      GO TO 815
  827 ANP=XCEND
      YXS(4) = X(4)-DELT(5,4)*ABS(X(4))
      IJ=341
      GO TO 815
  830 CONTINUE
      P(5,4)=(ANP-XCEND)/(2.*DELT(5,4)*ABS(Y(4)))
      YXS(4) = X(4)
      YXS(5) = X(5)+DELT(5,5)
      IJ = 35
      GO TO 815
  828 ANP=XCEND
```

```
      YXS(5) = X(5)-DELT(5,5)
      IJ =36
      GO TO 815
  829 P(5,5)=(ANP-XCEND)/(2.*DELT(5,5))
      YXS(5)=X(5)
      YXS(6)=X(6)+DELT(5,6)
      IJ=37
      GO TO 815
  840 ANP=XCEND
      YXS(6)=X(6)-DELT(5,6)
      IJ=38
      GO TO 815
  841 P(5,6)=(ANP-XCEND)/(2.*DELT(5,6))
      YXS(6)=X(6)
C---------P(6)--------
      IJ=40
  850 CALL OFSIM5(ANS5)
      IF(IJ.EQ.40) GO TO 851
      IF(IJ.EQ.41) GO TO 852
      IF(IJ.EQ.42) GO TO 853
      IF(IJ.EQ.43) GO TO 854
      IF(IJ.EQ.44) GO TO 855
      IF(IJ.EQ.45) GO TO 856
      IF(IJ.EQ.46) GO TO 857
      IF(IJ.EQ.47) GO TO 858
      IF(IJ.EQ.48) GO TO 859
      IF(IJ.EQ.49) GO TO 860
      IF(IJ.EQ.50) GO TO 861
      IF(IJ.EQ.51) GO TO 862
      IF(IJ.EQ.52) GO TO 863
  851 F(6)=-(ANS5-BIGS2)
      IJ=41
      YXS(1)=X(1)+DELT(6,1)
      GO TO 850
  852 ANP=ANS5
      IJ=42
      YXS(1)=X(1)-DELT(6,1)
      GO TO 850
  853 P(6,1)=(ANP-ANS5)/(2.*DELT(6,1))
      YXS(1)=X(1)
      IJ=43
      YXS(2)=X(2)+DELT(6,2)
      GO TO 850
  854 ANP=ANS5
      IJ=44
      YXS(2)=X(2)-DELT(6,2)
      GO TO 850
  855 P(6,2)=(ANP-ANS5)/(2.*DELT(6,2))
      IJ=45
      YXS(2)=X(2)
      YXS(3)=X(3)+DELT(6,3)
      GO TO 850
  856 ANP=ANS5
      IJ=46
      YXS(3)=X(3)-DELT(6,3)
      GO TO 850
  857 P(6,3)=(ANP-ANS5)/(2.*DELT(6,3))
      IJ=47
      YXS(3)=X(3)
      YXS(4)=X(4)+DELT(6,4)
```

```
      GO TO 850
  856 ANP=ANS5
      IJ=48
      YXS(4)=X(4)-DELT(6,4)
      GO TO 850
  859 P(6,4)=(ANP-ANS5)/(2.*DELT(6,4))
      IJ=49
      YXS(4)=X(4)
      YXS(5)=X(5)+DELT(6,5)
      GO TO 850
  860 ANP=ANS5
      IJ=50
      YXS(5)=X(5)-DELT(6,5)
      GO TO 850
  861 P(6,5)=(ANP-ANS5)/(2.*DELT(6,5))
      YXS(5)=X(5)
      YXS(6)=X(6)+DELT(6,6)
      IJ=51
      GO TO 850
  862 ANP=ANS5
      YXS(6)=X(6)-DELT(6,6)
      IJ=52
      GO TO 850
  863 P(6,6)=(ANP-ANS5)/(2.*DELT(6,6))
      YXS(6)=X(6)
      DO 666 IK=1,6
  666 WRITE(6,667)(P(IK,J),J=1,6)
  667 FORMAT(3X,*P(I,J)=*,6(E14.7,2X))
      NCAV1=NCAV+1
      DO 253 ICV=1,NCAV1,2
  253 WRITE(6,252) CAVX(ICV),CAVY(ICV)
  252 FORMAT(10X,*CAVX=*,F10.5,5X,*CAVY=*,F10.5)
      DO 129 ITX=1,6
  129 WRITE(6,131) ITX,F(ITX)
  131 FORMAT(1X,2HF(,I1,2H)=,E14.7)
      DO 132 IUP=1,6
      IF(ITERA.LE.3) GO TO 385
      DO 132 IUQ=1,6
  132 WRITE(6,133) IUP,IUQ,P(IUP,IUQ)
  133 FORMAT(1X,2HP(,I1,1H,,I1,2H)=,E14.7)
  385 CONTINUE
      CALL DETERM(P,6,DETBO)
      DO 25 IDET=1,6
      DO 26 LPG=1,6
      Q(LPG,IDET)=P(LPG,IDET)
   26 P(LPG,IDET)=F(LPG)
      CALL DETERM(P,6,DETE)
      IF(IDET.EQ.1) DELB=DETE/DETBO
      IF(IDET.EQ.2) DELC=DETE/DETBO
      IF(IDET.EQ.3) DELD=DETE/DETBO
      IF(IDET.EQ.4) DELE=DETE/DETBO
      IF(IDET.EQ.5) DELF=DETE/DETBO
      IF(IDET.EQ.6) DELG=DETE/DETBO
      DO 27 LPG=1,6
   27 P(LPG,IDET)=Q(LPG,IDET)
   25 CONTINUE
      X(1)=X(1)+DELB
      X(2)=X(2)+DELC
      X(3)=X(3)+DELD
      X(4)=X(4)+DELE
```

```
      X(5)=X(5)+DELF
      X(6)=X(6)+DELG
      DO 60 LMN=1,6
   60 WRITE(6,61) LMN,X(LMN)
   61 FORMAT(1X,2HX(,I1,2H)=,E14.7)
      ABSB=ABS(DELB/X(1))
      ABSC=ABS(DELC/X(2))
      ABSD=ABS(DELD/X(3))
      ABSE=ABS(DELE/X(4))
      ABSF=ABS(DELF/X(5))
      ABSG=ABS(DELG/X(6))
      KEIO=0
      IF(ABSB.LT.STOL) KEIO=1
      IF(ABSC.GT.STOL) KEIO=0
      IF(ABSD.GT.STOL) KEIO=0
      IF(ABSE.GT.STOL) KEIO=0
      IF(ABSF.GT.STOL) KEIO=0
      IF(ABSG.GT.STOL) KEIO=0
      IF(KEIO.EQ.1) GO TO 35
      I=I+1
      WRITE(6,42) I
   42 FORMAT(20X,14HITERATION NO.=,I2)
      IF(I.EQ.M) GO TO 35
      GO TO 55
   35 IF(I.EQ.M) GO TO 36
      GO TO 38
   36 WRITE(6,37)
   37 FORMAT(1X,34HOXFNE, DID NOT CONVERGE WITHIN 100)
      IF(X(1).LT.SI1) X(1)=SI1
      SI10=X(1)+2.*DG
      IF(X(2).LT.SI10) X(2)=SI10
      SI11=X(2)+2.*DG
      IF(X(3).LT.SI11) X(3)=SI11
      IF(X(6).LE.1.E-3) X(6)=1.E-3
      IF(X(4).LT.SI6)  X(4)=SI6
      SI5=(.5*PAI-GAMMA)*(1.-.02)
      IF(X(5).LT.0.) GO TO 81
      IF(X(5).GT.SI5) X(5)=SI5
      GO TO 82
   81 IF(ABS(X(5)).GT.SI5) X(5)=-SI5
   82 CONTINUE
   38 RETURN
      END
vv
```

```
      SUBROUTINE CFSIM1(ANS,NOF,XCA)
      DIMENSION XST(6)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AU(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON        SBETA,XXM,ICPI,SARCOD(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),      CLE,EPC,YYY,XM,ITERA,SXSIC(6),SXSICO(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XUU(200),XOX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),,GAUS(100),NGAUS
C     NOF     = 0  CALLED FROM F1INT.
C     NOF     = 1  CALLED FROM RMINT FOR REAL PART.
C     NOF     = 2  CALLED FROM RMINT FOR IMAG. PART.
C     NOF     = 3  CALLED FROM CAVITY DXFNE. AT F(5)
      IF (ICPI.EQ.0) GO TO 9
      DO 10 IQ = 1,6
   10 XST(IQ) = XSN(IQ)
      GO TO 12
    9 DO 11 IH = 1,6
   11 XST(IH) = YXS(IH)
   12 CONTINUE
      IF(ITERA.EQ.1) GO TO 222
      GO TO 223
  222 DO 224 ILK = 1,LPM
  224 BETAN(ILK) = SBETA
  223 CONTINUE
      CSPACE = (1.+XST(1))/FLOAT(LPK)
      FSPACE = CSPACE/FLOAT(LPM-LPK)
      LPM3=LPM-3
      XBET = -1.+CSPACE*FLOAT(LPK-1)
      XSI1=-1.+CSPACE
      BE1 = BETAN(2)
      AP1 = (XSI1-XST(2))/((XSI1+1.)*(XST(1)-XSI1)*(XSI1-XST(3)))
      AP1S = SQRT(AP1)
      F3 = BE1*AP1S
      XX1 = XST(4)*SIN(DELTA)
      YY1 = XST(4)*COS(DELTA)
      YY12 = YY1**2
      PLM = XSI1 -XX1
      PLM2 = PLM**2
      PLMA = PLM2+YY12
      PXSR = PLM/PLMA
      PXSI = YY1/PLMA
      IF(NOF.EQ.1) F3 = F3*PXSR
      IF(NOF.EQ.2) F3 = F3*PXSI
      IF(NOF.EQ.3) F3=F3/(XSI1-XCA)
      ANS=0.
      DO 1 I = 2,LPM3,2
      F1 = F3
      SPACE = CSPACE
      IF (I.GE.LPK) GO TO 30
      XSI2 = -1.+SPACE*FLOAT(I)
      XSII = XSI2+SPACE
      GO TO 31
   30 SPACE  = FSPACE
```

AD-A064 743 TETRA TECH INC PASADENA CALIF F/G 20/4
COMPUTER PROGRAM FOR CALCULATING PARTIALLY CAVITATING CASCADE F--ETC(U)
JAN 79 O FURUYA N00014-78-C-0146
UNCLASSIFIED TETRAT-TC-3951-02 NL

2 OF 2
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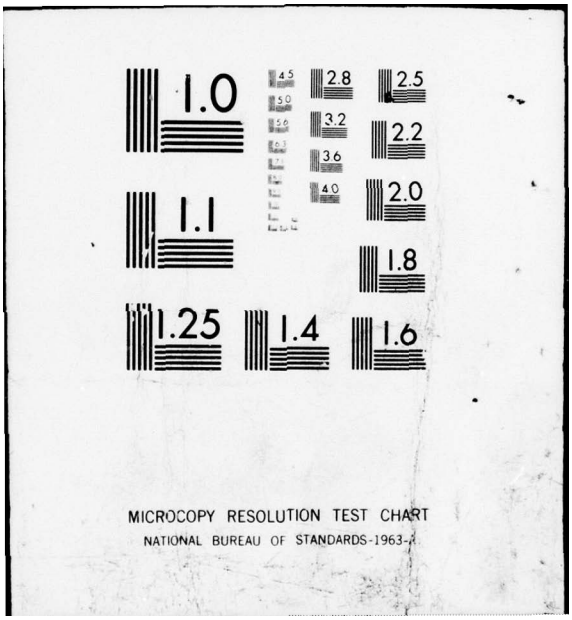
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4.5
5.0
5.6
6.3
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```
      XSI2 = XBET+SPACE*FLOAT(I-LPK+1)
      XSI3 = XSI2+SPACE
   31 BE2 = BETAN(I+1)
      BE3 = BETAN(I+2)
      AP2 = (XSI2-XST(2))/((XSI2+1.)*(XST(1)-XSI2)*(XSI2-XST(3)))
      AP3 = (XSI3-XST(2))/((XSI3+1.)*(XST(1)-XSI3)*(XSI3-XST(3)))
      AP2S = SQRT(AP2)
      AP3S = SQRT(AP3)
      F2 = BE2*AP2S
      F3 = BE3*AP3S
      HA2 = XSI2-XX1
      HA22 = HA2**2
      HB = HA22+YY12
      HCR2 = HA2/HB
      HCI2 = YY1/HB
      HA3 = XSI3-XX1
      HA32 = HA3**2
      HD=HA32+YY12
      HCR3 = HA3/HD
      HCI3 = YY1/HD
      IF(NOF.EQ.1) F2 = F2*HCR2
      IF(NOF.EQ.1)  F3 = F3*HCR3
      IF (NOF.EQ.2)  F2 = F2*HCI2
      IF(NOF.EQ.2)  F3 = F3*HCI3
      IF (NOF.EQ.3)  F2 = F2/(XSI2-XCA)
      IF(NOF.EQ.3)  F3 = F3/(XSI3-XCA)
      FSUM = (F1+4.*F2+F3)*SPACE/3.
      ANSA = ANSA+FSUM
    1 CONTINUE
      SG1 = SQRT((-1.-XST(2))/(-1.-XST(3)))
      SG2 = SQRT(XST(1)+1.)
      SG3 = SQRT((XST(1)-XST(2))/(XST(1)-XST(3)))
      ANT1 = BETAN(1)*2.*SQRT(CSPACE)*SG1/SG2
      ANT2 = BETAN(LPM)*2.*SQRT(FSPACE)*SG3/SG2
      APLA = -1.-XX1
      APLA2 = APLA**2
      APLB = AST(1)-XX1
      APLB2 = APLB**2
      IF(NOF.EQ.1) ANT1 = ANT1*APLA/(APLA2+YY12)
      IF (NOF.EQ.2 ) ANT1 = ANT1*YY1/(APLA2+YY12)
      IF (NOF.EQ.1) ANT2 = ANT2*APLB/(APLB2+YY12)
      IF (NOF.EQ.2) ANT2 = ANT2*YY1/(APLB2+YY12)
      IF (NOF.EQ.3) ANT1 = ANT1/(-1.-XCA)
      IF (NOF.EQ.3) ANT2 = ANT2/(XST(1)-XCA)
      ANS  = ANSA+ANT1+ANT2
      RETURN
      END
vv
```

```
      SUBROUTINE OFSIM2(ANS2)
      DIMENSION X(3),XIT(3),YY(3),XITC(3),EXU(3),FCN3(3),XST(6)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAS,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AU(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALPAI,GAMMA
      COMMON       SBETA,XXM,ICPI,SARCOO(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),     CLE,ERC,YYY,XM,ITEPA,SXSIO(6),SXSIOO(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),YJJ(200),XCX
      COMMON XKOUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A6,B6,C6,D6,TGAUS(100),WGAUS(100),NGAUS
      DO 13 I6=1,6
   13 XST(I6)=YXS(I6)
      PAI=3.141592653
      CCC1=ALOG(1.+XST(6))/(2.*PAI)
      UU2=COS(ALPA1+GAMMA)/COS(XST(5)+GAMMA)                                    C
C                              ECAPSE/)AMMAG+)5(TSX(SOC/)AMMAG+1AFLA(SOC=2UJ
      XKKK=ALOG(UU2)
      CSPACE=(1.+ XST(1))/FLOAT(LPK)
      HCSPAC=0.5*CSPACE
      FSPACE=CSPACE/FLOAT(LPM-LPK)
      HFSPAC=0.5*FSPACE
      XBET=-1.+CSPACE*FLOAT(LPK-1)
      CDE=COS(DELTA)
      SDE=SIN(DELTA)
      GA=XST(1)-XST(4)*SDE
      GB=XST(4)*CDE
      PPP=CDE/(GA**2+GB**2)
      FCN3(3)=DGAP*PPP*XST(1)/(PAI*SQRT(1.+XST(6)))
      LPKI=LPM-LPK+1
      DO 1 IP=1,LPM
      IF(IP.EQ.1) GO TO 2
      HSPACE=HFSPAC
      SPACE=FSPACE
      IF(IP.GT.LPKI) GO TO 30
      X(1)=XST(1)-SPACE*FLOAT(IP-2)
      X(2)=X(1)-HSPACE
      X(3)=X(1)-SPACE
      GO TO 31
   30 HSPACE=HCSPAC
      SPACE=CSPACE
      X(1)=XBET-SPACE*FLOAT(IP-LPKI-1)
      X(2)=X(1)-HSPACE
      X(3)=X(1)-SPACE
   31 FCN3(1)=FCN3(3)
      NK=3
      IF(IP.EQ.LPM) NK=2
      DO 6 I=2,NK
      IF(IJ.GE.23) GO TO 3
      GO TO 7
    3 IF(I.EQ.2) XIT(2)=XITM(LPM-IP+1)
      IF(I.EQ.3) XIT(3)=XITN(LPM-IP+1)
      GO TO 5
    7 CONTINUE
      YY(I)=X(I)
C OFSIM3 CALCULATE G1 .
```

```
      CALL DFSIM3(YY(I),XITC(I),IP,I)
      XIT(I)=XITC(I)
      IF(IJ.EQ.18) GO TO 6
      GO TO 5
    6 IF(I.EQ.2) XITM(LPM-IP+1)=XIT(I)
      IF(I.EQ.3) XITN(LPM-IP+1)=XIT(I)
    5 CONTINUE
      EXU(I)=EXP(-XIT(I))
      GC=X(I)-XST(4)*SDE
      GD=XST(4)*CDE
      PXA=GC**2+GD**2
      DWDX=DGAP*X(I)*CDE/(PXA*PAI)
      FCN3(I)=EXU(I)*DWDX/JJ2
      IF(X(I).LE.0.) FCN3(I)=-FCN3(I)
    8 CONTINUE
C CHECK IF FCN3(I) IS ALWAYS POSITIVE.
      IF(IP.EQ.LPM) GO TO 20
      GO TO 21
   20 PPG=CDE/((-1.-XST(4)*SDE)**2+(XST(4)*CDE)**2)
      FF3=DGAP*PPG/PAI
      FCN3(3)=FF3
   21 SUM=(FCN3(1)+FCN3(2)*4.+FCN3(3))*HSPACE/3.
      ANS2=ANS2+SUM
      IF(IJ.EQ.18) SARC(LPM-IP+1)=ANS2
      GO TO 1
    2 SARC(LPM)=0.
      ANS2=0.
    1 CONTINUE
C XITN(LPM)=G1 AT POINT B.
C XINT(1)=G1 AT POINT X=1.
      XITN(LPM)=CCC1-XKKK/PAI
      XITN(1)=0.
      RETURN
      END
VV
```

```
      SUBROUTINE OFSIM3(Y,XXII,IP,I)
      DIMENSION XST(6),FA(200)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITV(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON       SBETA,XXM,ICPI,SARCOD(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),     CLE,ERC,YYY,XM,ITERA,SXS10(6),SXSIOO(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XCX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TSAUS(100),,GAUS(100),NGAUS
C     FOUR INTEGRALS TO BE EVALJATED BEFORE XI IS OBTAINED.
C     NOTE THAT PRIVIOUSLY ONLY ONE  SINGULAR INTEGRAL WAS
C     CALCULATED IN GCASCAD AND CASCADE.
C     SEE THE NOTE OF TC 3981 FOR FOUR INTEGRALS, OUT OF WHICH
C     TWO ARE OF SINGULAR TYPE.
      IF(ICPI.EQ.0) GO TO 9
      DO 11 ISI=1,6
   11 XST(ISI)=XSN(ISI)
      GO TO 12
    9 DO 13 JTJ=1,6
   13 XST(JTJ)=YXS(JTJ)
   12 PAI=3.141592653
      CCC1=ALOG(1.+XST(6))/(2.*PAI)
C-----FIRS  I1-------
      IF (ITERA.EQ.1) GO TO 60
      GO TO 61
   60 CONTINUE
      DO 62 IZU = 1,LPM
      BETAN(IZU) = SBETA
      BETAM(IZU) = SBETA
   62 CONTINUE
   61 CONTINUE
      CSPACE=(1.+ XST(1))/FLOAT(LPK)
      HCSPAC=0.5*CSPACE
      FSPACE=CSPACE/FLOAT(LPM-LPK)
      HFSPAC=0.5*FSPACE
      XBET=-1.+CSPACE*FLOAT(LPK-1)
      AB2=SQRT(XST(1)+1.)
      AB3=SQRT((1.+Y)*(XST(1)-Y))
      AB6 = SQRT((XST(3)-Y)/(XST(2)-Y))
      AB3 = AB3*AB6
      IJ2=LPM-IP+1
      IJ3=1
      IF(I.EQ.3) IJ3=LPM-IP+1
      IF(I.EQ.0) IJ3=IP
      BEC=BETAN(IJ3)
      IF(I.EQ.2) BEC=BETAM(IJ2)
      FAA=BEC/AB3
      LPM1=LPM-1
      DO 1 IW=2,LPM1
      SPACE=CSPACE
      IF(I.GT.LPK) GO TO 45
      XSK=-1.+SPACE*FLOAT(IW-1)
      GO TO 46
   45 SPACE=FSPACE
```

```
      XSK=XBET+ SPACE*FLOAT(IJ-LPK)
   46 IF(I.EQ.2) GO TO 6
      IF(I..EQ.IJ3) GO TO 1
    6 FS=SQRT((1.+XSK)*(XST(1)-XSK))
      FSA1 = SQRT((XST(3)-XSK)/(XST(2)-XSK))
      FS = FS*FSA1
      FA(IJ)=(BETAN(IL)/FS-FAA)/(XSK-Y)
    1 CONTINUE
      IF(I.EQ.2) GO TO 30
      XP1=-1.+HCSPAC
      XP2=XP1+CSPACE
      XP4=XST(1)-HFSPAC
      XP3=XP4-FSPACE
      FS1=BETAM(1)/ SQRT((1.+XP1)*(XST(1)-XP1))
      FS2=BETAM(2)/ SQRT((1.+XP2)*(XST(1)-XP2))
      FS3=BETAM(LPM-2)/ SQRT((1.+XP3)*(XST(1)-XP3))
      FS4=BETAM(LPM-1)/ SQRT((1.+XP4)*(XST(1)-XP4))
      FSA1 = SQRT((XST(2)-XP1)/(XST(3)-XP1))
      FSA2 = SQRT((XST(2)-XP2)/(XST(3)-XP2))
      FSA3=SQRT((XST(2)-XP3)/(XST(3)-XP3))
      FSA4=SQRT((XST(2)-XP4)/(XST(3)-XP4))
      FS1=FS1*FSA1
      FS2=FS2*FSA2
      FS3=FS3*FSA3
      FS4=FS4*FSA4
      FP1=(FS1-FAA)/(XP1-Y)
      FP2=(FS2-FAA)/(XP2-Y)
      FP3=(FS3-FAA)/(XP3-Y)
      FP4=(FS4-FAA)/(XP4-Y)
      IF(IU3.EQ.2) GO TO 21
      IF(IU3.EQ.LPM1) GO TO 22
      IF(IU3.EQ.LPK) GO TO 51
      FA(IU3)=0.5*(FA(IU3-1)+FA(IU3+1))
      GO TO 30
   51 BETO=2.*BETAN(LPK)-BETAN(LPK+1)
      XOA=XBET-FSPACE
      FPW=BETO/SQRT((1.+XOA)*(XST(1)-XOA))
      FPSA = SQRT((XST(2)-XOA)/(XST(3)-XOA))
      FPA=FPWA*FPA
      FLPK=(FPW-FAA)/(XOA-Y)
      FA(IU3)=0.5*(FA(IU3+1)+FLPK)
      GO TO 30
   21 FA(IU3)=(FP1+FP2)/2.
      GO TO 30
   22 FA(IU3)=(FP3+FP4)/2.
   30 XI=0.
      LPM3=LPM-3
      SPACE=CSPACE
      DO 15 JA=2,LPM3,2
      IF(JA.GE.LPK) SPACE=FSPACE
   15 XI=XI+(FA(JA)+4.*FA(JA+1)+FA(JA+2))*SPACE/3.
      IF(I.EQ.2) GO TO 35
      XI25=0.5*HCSPAC*(FP1+FA(2))+(FA(LPM-1)+FP4) *0.5*HFSPAC
      XKI=41.
      KU=39
      LPMA=LPM-5
      IF(IU3.GE.LPMA) XKI=201.
      IF(IU3.GE.LPMA) KU=199
      BOZ=(BETAM(1)-BETAN(1))/XKI
      BOY=(BETAN(LPM)-BETAM(LPM1))/XKI
```

```
      HFF=HFSPAC/XKI
      HFH=HCSPAC/XKI
      FT3=FP1
      FU3=FP4
      XI4=0.
      XI1=0.
      DO 202 ITM=1,KU,2
      FT1=FT3
      FU1=FU3
      XM2=XST(1)-HFSPAC+HFF*FLOAT(ITM)
      XM3=XM2+HFF
      XT2=-1.+HCSPAC-HFH*FLOAT(ITM)
      XT3=XT2-HFH
      BETA2=BETAM(LPM1)+BCY*FLOAT(ITM)
      BETA3=BETA2+BCY
      BETT2=BETAM(1)-BCZ*FLOAT(ITM)
      BETT3=BETT2-BCZ
      FS2=BETA2/SQRT((1.+XM2)*(XST(1)-XM2))
      FS3=BETA3/SQRT((1.+XM3)*(XST(1)-XM3))
      FV2=BETT2/SQRT((1.+XT2)*(XST(1)-XT2))
      FV3=BETT3/SQRT((1.+XT3)*(XST(1)-XT3))
      FS2A = SQRT((XST(2)-XM2)/(XST(3)-XM2))
      FS3A = SQRT((XST(2)-XM3)/(XST(3)-XM3))
      FV2A = SQRT((XST(2)-XT2)/(XST(3)-XT2))
      FV3A = SQRT((XST(2)-XT3)/(XST(3)-XT3))
      FS2 = FS2*FS2A
      FS3 = FS3*FS3A
      FV2 = FV2*FV2A
      FV3 = FV3*FV3A
      FU2=(FS2-FAA)/(XM2-Y)
      FU3=(FS3-FAA)/(XM3-Y)
      FT2=(FV2-FAA)/(XT2-Y)
      FT3=(FV3-FAA)/(XT3-Y)
      XI4=XI4+HFF*(FU1+FU2*4.+FU3)/3.
  202 XI1=XI1+HFH*(FT1+FT2*4.+FT3)/3.
      XA4=BETAN(LPM)*2.*SQRT(HFF)/(AB2*(XST(1)-Y))
      XA4A = SQRT((XST(2)-XST(1))/(XST(3)-XST(1)))
      XA4 = XA4*XA4A
      XI4=XI4+XA4
      XA1=BETAN(1)*2.*SQRT(HFH)/(AB2*(-1.-Y))
      XA1A = SQRT((XST(2)+1.)/(XST(3)+1.))
      XA1 = XA1*XA1A
      XI1=XI1+XA1
      XI=(XI+XI23+XI1+XI4)*AB3/PAI
      XI=XI+BEC*ALOG((XST(1)-Y-HFF)/(1.+Y-HFH))/PAI
      XXI1=-XI
      GO TO 36
   35 XR1=-1.+0.5*HCSPAC
      XR2=XR1+HCSPAC
      XR4=XST(1)-0.5*HFSPAC
      XR3=XR4-HFSPAC
      FT1=0.5*(BETAN(1)+BETAM(1))/ SQRT((1.+XR1)*(XST(1)-XR1))
      FT2=0.5*(BETAM(1)+BETAN(2))/ SQRT((1.+XR2)*(XST(1)-XR2))
      FT3=0.5*(BETAN(LPM-1)+BETAM(LPM-1))/ SQRT((1.+XR3)*(XST(1)-XR3))
      FT4=0.5*(BETAM(LPM-1)+BETAN(LPM))/ SQRT((1.+XR4)*(XST(1)-XR4))
      FT1A = SQRT((XST(2)-XR1)/(XST(3)-XR1))
      FT2A = SQRT((XST(2)-XR2)/(XST(3)-XR2))
      FT3A = SQRT((XST(2)-XR3)/(XST(3)-XR3))
      FT4A = SQRT((XST(2)-XR4)/(XST(3)-XR4))
      FT1 = FT1*FT1A
```

```
      FT2 = FT2*FT2A
      FT3 = FT3*FT3A
      FT4 = FT4*FT4A
      FR1=(FT1-FAA)/(XR1-Y)
      FR2=(FT2-FAA)/(XR2-Y)
      FR3=(FT3-FAA)/(XR3-Y)
      FR4=(FT4-FAA)/(XR4-Y)
      XIP1=0.5*HCSPAC*(FR1+FR2)+0.5*HFSPAC*(FR3+FR4)
      XIP2=0.25*HCSPAC*(FR2+FA(2))+0.25*HFSPAC*(FA(LPM-1)+FR3)
      XI23=XIP1+XIP2
      XMI=21.
      XMI2=42.
      MJ=21
      M2=MU-2
      LPMA=LPM-5
      IF(IU2.GE.LPMA) XMI=101.
      IF(IU2.GE.LPMA) XMI2=202.
      IF(IU2.GE.LPMA) MJ=101
      IF(IU2.GE.LPMA) M2=MU-2
      BETY=(BETAN(LPM)-BETAM(LPM-1))/XMI2
      BESS=0.5*(BETAN(LPM)+BETAM(LPM-1))
      HSP6=0.5*HFSPAC/XMI
      FG3=FR4
      BETY1=(BETAM(1)-BETAN(1))/XMI2
      BESS1=0.5*(BETAM(1)+BETAN(1))
      HSP61=0.5*HCSPAC/XMI
      FG31=FR1
      XI1=0.
      XI4=0.
      DO 129 IL=1,M2,2
      FG1=FG3
      FG11=FG31
      X2=XST(1)-HSP6*FLOAT(MU-IL)
      X3=X2+HSP6
      X21=-1.+HSP61*FLOAT(MU-IL)
      X31=X21-HSP61
      BETA2=BESS+BETY*FLOAT(IL)
      BETA3=BESS+BETY*FLOAT(IL+1)
      BETA21=BESS1-BETY1*FLOAT(IL)
      BETA31=BETA21-BETY1
      FU21=BETA21/ SQRT((1.+X21)*(XST(1)-X21))
      FU31=BETA31/ SQRT((1.+X31)*(XST(1)-X31))
      FU21A = SQRT((XST(2)-X21)/(XST(3)-X21))
      FU31A = SQRT((XST(2)-X31)/(XST(3)-X31))
      FU21 = FU21*FU21A
      FU31 = FU31*FU31A
      FG21=(FU21-FAA)/(X21-Y)
      FG31=(FU31-FAA)/(X31-Y)
      FU2=BETA2/ SQRT((1.+X2)*(XST(1)-X2))
      FU3=BETA3/ SQRT((1.+X3)*(XST(1)-X3))
      FU2A = SQRT((XST(2)-X2)/(XST(3)-X2))
      FU3A = SQRT((XST(2)-X3)/(XST(3)-X3))
      FU2 = FU2*FU2A
      FU3 = FU3*FU3A
      FG2=(FU2-FAA)/(X2-Y)
      FG3=(FU3-FAA)/(X3-Y)
      XI1=XI1+HSP61*(FG11+FG21*4.+FG31)/3.
  129 XI4=XI4+HSP6*(FG1+4.*FG2+FG3)/3.
      XIA=2.*SQRT(HSP6)*BETAN(LPM)/(AB2*(XST(1)-Y))
      XIAA = SQRT((XST(2)-XST(1))/(XST(3)-XST(1)))
```

```
      XIA = XIA+XIAA
      XI4=XI4+XIA
      XIB=2.*SQRT(HSP61)*BETAN(1)/(AB2*(-1.-Y))
      XIBA = SQRT((XST(2)+1)/(XST(3)+1.))
      XIB = XIB*XIBA
      XI1=XI1+XIB
      XI=(XI+XI1+XI23+XI4)*AB3/PAI
      XI=XI+BEC*ALOG((XST(1)-Y-HSP6)/(1.+Y-HSP61))/PAI
      XXI1=-XI
   36 CONTINUE
C-------I2-----------
C----------IF Y IS LESS THAN ZERO, THIS IS A
C-----REGULAR INTEGRAL, WHILE Y .GE. 0, THIS IS A
C-----SINGULAR INTEGRAL.
C     BUT THIS IS TREATED AS A SINGULAR INTEGRAL ANYWAY
      ISIC=3
      XCA=Y
      CALL IC2(SR,SM,XCA,ISIC)
      XXI2=SR
      ARGL=(XST(1)      -Y)/Y
      IF (ARGL.LT.0.) ARGL=-ARGL
      XXI2=XXI2*AB3+ALOG(ARGL)
      XXI2=-XXI2
C-----I3----------
C     USE CHEBYSHEV-GAUSS QUADRATURE.
C     AJ(I) ARE ALREADY CALCULATED IN SUBROUTINE F1INTL
C     AND PASSED ONTO HERE BY COMMON STATEMENT.
      XXI3 = 0.
      BPC5 = (XST(1)+XST(2))*.5
      CMB5 = (XST(2)-XST(1))*.5
      A31 = (BPC5+1.)/CMB5
      A32 = (-BPC5+XST(3))/CMB5
      DO 120 ISUM = 1,NCHBY
      HA1 = 1.-AJ(ISUM)
      HA2 = (AJ(ISUM)+A31)*(A32-AJ(ISUM))
      SHA2 = SQRT(HA2)
      F3I3 = HA1/SHA2
      F3AI3 = CMB5*AJ(ISUM)+BPC5-Y
  120 XXI3 = XXI3+F3I3/F3AI3
      XXI3 = XXI3*PAI/NCHBY
      UU22 = COS(ALFA1+GAMMA)/COS(XST(5)+GAMMA)
      HX3 = CCC1-ALOG(UU22)/PAI
      XXI3 = XXI3*AB3*HX3
C-----I4----------
C     USE CHEBYSHEV-GAUSS QUADRATURE FORMULA---
C------BBETAN2(I) ARE ALREADY CALCULATED IN
C     SUBROUTINE F1INTL AND PASSED ONTO HERE BY
C     COMMON STATEMENT.
      FPC5 = (XST(3)+XST(2))*.5
      FMC5 = (XST(3)-XST(2))*.5
      A41 = (FPC5+1.)/FMC5
      A42 = (FPC5-XST(1))/FMC5
      XXI4 = 0.
      DO 130 ISUM = 1,NCHBY
      PAX = (BBTAN2(ISUM)+PAI)*(1.+AJ(ISUM))
      PBX = (AJ(ISUM)+A41)*(AJ(ISUM)+A42)
      SRBX = SQRT(RBX)
      RCX = PAX/SRBX
      RDX = FMC5*AJ(ISUM)+FPC5-Y
  130 XXI4 = XYI4 + RCX/RDX
```

```
      XIA = XIA*XIAA
      XI4=XI4+XIA
      XIB=2.*SQRT(HSP61)*BETAN(1)/(AB2*(-1.-Y))
      XIBA = SQRT((XST(2)+1)/(XST(3)+1.))
      XIB = XIB*XIBA
      XI1=XI1+XIB
      XI=(XI+XI1+XI23+XI4)*AB3/PAI
      XI=XI+BEC*ALOG((XST(1)-Y-HSP6)/(1.+Y-HSP61))/PAI
      XJI1=-XI
   36 CONTINUE
C-------I2----------
C----------IF Y IS LESS THAN ZERO, THIS IS A
C-----REGULAR INTEGRAL, WHILE Y .GE. 0, THIS IS A
C-----SINGULAR INTEGRAL.
C     BUT THIS IS TREATED AS A SINGULAR INTEGRAL ANYWAY
      ISIC=3
      XCA=Y
      CALL IC2(SR,SM,XCA,ISIC)
      XXI2=SR
      ARGL=(XST(1)      -Y)/Y
      IF (ARGL.LT.0.) ARGL=-ARGL
      XXI2=XXI2*AB3+ALOG(ARGL)
      XXI2=-XXI2
C-----I3----------
C     USE CHEBYSHEV-GAUSS QUADRATURE.
C     AJ(I) ARE ALREADY CALCULATED IN SUBROUTINE F1INTL
C     AND PASSED ONTO HERE BY COMMON STATEMENT.
      XXI3 = 0.
      BPC5 = (XST(1)+XST(2))*.5
      CMB5 = (XST(2)-XST(1))*.5
      A31 = (BPC5+1.)/CMB5
      A32 = (-BPC5+XST(3))/CMB5
      DO 120 ISUM = 1,NCHBY
      HA1 = 1.-AJ(ISUM)
      HA2 = (AJ(ISUM)+A31)*(A32-AJ(ISUM))
      SHA2 = SQRT(HA2)
      F3I3 = HA1/SHA2
      F3AI3 = CMB5*AJ(ISUM)+BPC5-Y
  120 XXI3 = XXI3+F3I3/F3AI3
      XXI3 = XXI3*PAI/NCHBY
      UU22 = COS(ALFA1+GAMMA)/COS(XST(5)+GAMMA)
      HX3 = CCC1-ALOG(UU22)/PAI
      XXI3 = XXI3*AB3*HX3
C-----I4----------
C     USE CHEBYSHEV-GAUSS QUADRATURE FORMULA---
C-----BBETAN2(I) ARE ALREADY CALCULATED IN
C     SUBROUTINE F1INTL AND PASSED ONTO HERE BY
C     COMMON STATEMENT.
      FPC5 = (XST(3)+XST(2))*.5
      FMC5 = (XST(3)-XST(2))*.5
      A41 = (FPC5+1.)/FMC5
      A42 = (FPC5-XST(1))/FMC5
      XXI4 = 0.
      DO 130 ISUM = 1,NCHBY
      RAX = (BBTAN2(ISUM)+PAI)*(1.+AJ(ISUM))
      REX = (AJ(ISUM)+A41)*(AJ(ISUM)+A42)
      SRBX = SQRT(REX)
      RCX = RAX/SRBX
      RDX = FMC5*AJ(ISUM)+FPC5-Y
  130 XXI4 = XXI4 + RCX/RDX
```

```
      XXI4 = XXI4*PAI/NCHBY
      XXI4 = -XXI4*ABS/PAI
      XXII = XXI1+XXI2+XXI3+XXI4
      IWRIT1=2
      IWRIT2=30
      IWRIT3=60
      IF (IJ.EQ.18.AND.IP.EQ.IWRIT1) WRITE(6,55) XXI1,XXI2,XXI3 ,XXI4,IP
      IF (IJ.EQ.18.AND.IP.EQ.IWRIT2) WRITE(6,55) XXI1,XXI2,XXI3,XXI4,IP
      IF (IJ.EQ.18.AND.IP.EQ.IWRIT3) WRITE (6,55) XXI1,XXI2,XXI3,XXI4,IP
   55 FORMAT (10X,'----I1,I2,I3,I4 OF F(4) ARE----',4(E14.7,2X),2X,
     A'IP=',I4)
      RETURN
      END
vv
```

```
      SUBROUTINE OFSIM5(ANS5)
      DIMENSION S2SR(101),S2KER(101),XST(6)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON       SBETA,XXM,ICP1,SARCOO(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,OSS
      COMMON XSN(6),     CLE,ERC,YYY,XM,ITERA,SXSIC(6),SXSIOO(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IU,LPK,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
      PAI=3.141592654
C     THIS SUBROUTINE CALLED FROM OXFNE..
C     USE SIMPSON'S RULE.
      DO 1 IMO = 1,6
    1 XST(IMO) = YXS(IMO)
      CDE = COS(DELTA)
      SDE = SIN(DELTA)
C  NS2 SHOULD HAVE A FACTOR OF 4.
C NS2=LPMM=LPM2
      NS21 = NS2+1
      NS2A = NS2-1
      S2GAP = (XST(3)-XST(2))/NS2
C                          ECAPSE/)AMMAG+)5(TSX(SOO/)AMMAG+1AFLA(SOO = 2UJ
      JJ2 = COS(ALFA1+GAMMA)/COS(XST(5)+GAMMA)                                C
      DO 2 IS2 = 1,NS21
      XS2 = XST(2)+S2GAP*(IS2-1)
      XKD = XS2*CDE
      XMAS = XS2-XST(4)*SDE
      XMAS2 = XMAS**2
      ASD = XST(4)*CDE
      ASD2 = ASD**2
      DWDX = DGAP*XKD/((XMAS2+ASD2)*PAI)
      IF (IS2.EQ.1) GO TO 3
      IF (IS2.EQ.NS21) GO TO 4
      CALL G2 (XS2,ANSG2,IS2)
C     G2 CALCULATES G2 WITH XSI GIVEN.
      EG2 = EXP(-ANSG2)
      IF(IU.EQ.40) ANSG2S(IS2)=ANSG2
      S2KER(IS2) = EG2*DWDX/JJ2
      GO TO 2
    3 CONTINUE
      S2KER(1) = DWDX/SQRT(1.+XST(6))
      ANSG2S(IS2)=ALOG(SQRT(1.+XST(6))/JJ2)
      GO TO 2
    4 CONTINUE
      S2KER(NS21) = DWDX/JJ2
      ANSG2S(IS2)=0.
    2 CONTINUE
      S2SR(1) = 0.
      DO 10 JS2 = 1,NS2A,2
   10 S2SR(JS2+2) = S2SR(JS2)
     1+(S2KER(JS2)+4.*S2KER(JS2+1)+S2KER(JS2+2))*S2GAP/3.
      IF(IU.NE.40) GO TO 40
      SARC2(1)=0.
      DO 50 ISARC=2,NS2,2
```

```
      50 S2SR(ISARC)=.5*(S2SR(ISARC-1)+S2SR(ISARC+1))
         DO 30 ISARC=1,NS21
      30 SARC2(ISARC)=S2SR(ISARC)
      40 CONTINUE
         ANS5 = S2SR(NS21)
         RETURN
         END
vv
```

```
      SUBROUTINE IC2(SR,SM,XCA,ISIC)
      DIMENSION XST(6)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALPA1,GAMMA
      COMMON        SBETA,AXM,ICPI,SARCOD(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),     CLE,ERC,YYY,XM,ITERA,SXSIO(6),SXSIOO(6),YYS(6)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,JE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XOX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AS,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
      DO 1 IPN = 1,6
    1 XST(IPN) = YXS(IPN)
      XX1 = XST(4)*SIN(DELTA)
      YY1 = XST(4)*COS(DELTA)
      YY12 = YY1**2
C     ISIC = 0 FOR RMINT
C          = 1 IN CAVITY OF OPSIMS FOR F(5) AND IN CAVITY.
C            2 CALLED FROM FIINTL FOR F(1).
C            3 FOR I2 OF F(4).
      SR=0.
      SM=0.
      BH=XST(1)*.5
      BHMC=BH-XST(2)
      BHP1=BH+1.
      BHMF=BH-XST(3)
      B11=BHMC/BH
      B12=BHP1/BH
      B13=BHMF/BH
      IF(ISIC.NE.3) GO TO 20
      AP1=(XCA+1.)*(XST(1)-XCA)*(XCA-XST(3))
      AP2=XCA-XST(2)
      APS=SQRT(AP1/AP2)
   20 CONTINUE
      DO 7 ISUM=1,NCHBY
      RA=(AJ(ISUM)+B11) *(AJ(ISUM)+1.)
      RB=(AJ(ISUM)+B12)*(AJ(ISUM)+B13)
      SAB=SQRT(RA/RB)
      SAC=BH*SQRT(1.-AJ(ISUM)**2)/SAB
      XSIP=BH*AJ(ISUM)+BH
      XPXP=XSIP-XX1
      XPXP2=XPXP**2
      RV2=XPXP2+YY12
      RWR=XPXP/RV2
      RWI=YY1/RV2
      IF(ISIC.EQ.1) RWR=1./(XSIP-XCA)
      IF(ISIC.EQ.2) RWR=1.
      IF(ISIC.EQ.3) RWR=(1.-SAC/APS)/( XSIP-XCA)
      SR=SR+SAB*RWR
    7 SM=SM+SAB*RWI
      PAI=3.141592654
      SR=SR*PAI/NCHBY
      SM=SM*PAI/NCHBY
      RETURN
      END
vv
```

```
      SUBROUTINE FIINTL(YINT,KCTRL)
      DIMENSION xST(6)
      COMMON YCCC,SBETA2
      COMMON xITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALPA1,GAMMA
      COMMON       SBETA,KKM,ICPI,SARCOD(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),     DLE,ERC,YYY,XM,ITERA,SXSIG(6),SXSIOO(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
C     SUBROUTINE FIINTL CALCULATES THE INTEGRALS IN F(1)
C     ISHARP = 0 FOR SHARP L.E.FOILS.
C     ISHARP = 1 FOR ROUNDED L.E.FOILS.
C     IF FOILS HAVE ROUNDED L.E., CHEBYSHEV-GAUSS
C     QUADRATUE
C     QUADRATURE FORMULA CAN NOT BE USED.  SINCE BETA
C     IS NOT A SMOOTH FUNCTION.
C     NCHBY = NUMBER OF CHEBYSHEV-GAUSS QUADRATURE CONTROL POINTS.
      PAI = 3.141592654
      IF(ICPI.EQ.0) GO TO 5
      DO 70 IG = 1,6
   70 XST(IG) = XSN(IG)
      GO TO 12
    9 DO 11 IH = 1,6
   11 XST(IH) = YXS(IH)
   12 CONTINUE
    5 DN1 = (XST(1)+1.)*.5
      DN2 = (XST(1)-1.)*.5
      A11 = (DN2-XST(2))/DN1
      A12 = (DN2-XST(3))/DN1
      BC5 = (XST(1)+XST(2))*.5
      CMBE=(XST(2)-XST(1))*.5
      A31 = (BC5+1.)/CMB5
      A32 = (-BC5+XST(3))/CMB5
      FCA5 = (XST(3)-XST(2))*.5
      FC15 = (XST(3)+XST(2))*.5
      A41 = (FC15+1.)/FCA5
      A42 = (FC15-XST(1))/FCA5
      SPACE2 = (XST(3)-XST(2))/LPMM
C     READ LPMM FOR THE SECOND ARC.
      IF(KCTRL.GE.2) GO TO 100
      IF(IJ.GE.2) GO TO 100
      CSPACE = (1.+XST(1))/FLOAT(LPK)
      FSPACE = CSPACE/FLOAT(LPM-LPK)
      IOM = 1
      XCHCK = -1.
      SPACE=CSPACE
      DO 20 ICHBY=1,NCHBY
      NCH=NCHBY-ICHBY+1
      AJ(ICHBY)=COS((2*NCH-1)*PAI/(2*NCHBY))
      XKSI=DN1*AJ(ICHBY)+DN2
      IF(ITERA.EQ.1) GO TO 485
   22 IF(XCHCK.GE.XKSI) GO TO 21
      IF(IOM.GE.LPK) SPACE = FSPACE
      XCHCK = XCHCK+SPACE
```

```
      IOM = IOM+1
      GO TO 22
C  XKSI EXISTS BTW XSI(IOM-1) AND XSI(IOM)
   21 CONTINUE
      IOMA = IOM-1
      BBTAN(ICHBY) = BETAN(IOM)+(BETAN(IOM)-BETAN(IOMA))
     X*(XKSI-XCHCK)/SPACE
C     BBTAN IS USED FOR CHEBYCHEV-GAUSS INSTEAD OF BETAN.
      GO TO 20
  488 BBTAN(ICHBY) = SBETA
C BETAN FOR ITERA.EQ.1 IS SPECIFIED IN OFSIM1.
   20 CONTINUE
  100 CONTINUE
      IF(KCTRL.EQ.4) GO TO 4
      IF (KCTRL.EQ.3) GO TO 3
      IF (KCTRL.EQ.2) GO TO 2
      IF (ISHARP.EQ.1) GO TO 10
      YINT  = 0.
      DO 110 ISUM = 1,NCHBY
      ABC = (AJ(ISUM)+A11)/(AJ(ISJM)+A12)
  110 YINT  = YINT +BETAN(ISUM)*SQRT(ABC)
      YINT = YINT*PAI/NCHBY
      GO TO 1000
   10 CONTINUE
C  THIS IS THE CASE OF HANDLING RNDED L.E. .
      NOF = 0
      XCA = 0.
      CALL OFSIM1(YINT,NOF,XCA)
C     XCA IS DUMMY, ONLY USED FOR F(5) IN)XFNEW.
      GO TO 1000
    2 CONTINUE
      XCA=0.
C XCA IS DUMMY.
      ISIC=2
      CALL IC2(SR,SM,XCA,ISIC)
      YINT=SR
      GO TO 1000
    3 CONTINUE
C-----INTEGRAL FOR I3.
C  AJ(N) IS CALCULATED AND STORED
      YINT = 0.
      DO 120 ISUM = 1,NCHBY
      AB1 = 1.-AJ(ISUM)
      AB2 = (AJ(ISUM)+A31)*(A32-AJ(ISUM))
      SQAB2 = SQRT(AB2)
      ABC = AB1/SQAB2
  120 YINT = YINT+ABC
      YINT = YINT*PAI/NCHBY
      GO TO 1000
C-----INTEGRAL FOR I4
C     SINCE BETA(N) BTWN TCT AND TET ARE
C     EXPECTED TO BE ALWAYS SMOOTH, USE GAUSS-
C     CHEBYSHEV QUADRATURE FORMULA.
C     AJ(N) IS ALREADY CALCULATED.
C     IF THIS IS THE FIRST CASE FOR BETAN2,
C     USE A CONSTANT FOR BETAN2.
C     BETAN2 IS USED FOR CHEVY-GAUSS INSTEAD OF BETAN2.
    4 CONTINUE
      IF(ITERA.GE.2) GO TO 150
      IF(IJ.GE.2) GO TO 151
```

```
C  SBETA2 MUST BE READ FOR THE FIRST RUN.
      DO 160 ICHBY = 1,NCHBY
  160 BBTAN2 (ICHBY) = SBETA2
      NS21=NS2+1
      DO 165 IOC=1,NS21
  165 BETAN2(IOC)=SBETA2
      GO TO 161
  150 CONTINUE
      IF(IJ.GE.2) GO TO 181
      IOMM = 1
      XCHCK = XST(2)
      DO 170 ICHBY = 1,NCHBY
      XKSI = FCA5*AJ(ICHBY)+FC15
  152 IF(XCHCK.GE.XKSI) GO TO 151
      XCHCK = XCHCK + SPACE2
      IOMM = IOMM+1
      GO TO 152
  151 CONTINUE
      IOMMA = IOMM-1
      BBTAN2(ICHBY) = BETAN2(IOMM)
     1+(BETAN2(IOMM)-BETAN2(IOMMA))*(XKSI-XCHCK)/SPACE2
      ILM=ICHBY
      XKSI = FCA5*AJ(ILM  )+FC15
      WRITE(6,250) ILM,BBTAN2(ILM),XKSI
  250 FORMAT(15X,'I=',I3,2X,'BBTAN2=',E14.7,2X,'XKSI=',E14.7)
  170 CONTINUE
  181 CONTINUE
      YINT = 0.
      DO 190 ISUM = 1,NCHBY
      AB1 = (BBTAN2(ISUM)+PAI)*(1.+AJ(ISUM))
      AB2 = (AJ(ISUM)+A41)*(AJ(ISUM)+A42)
      SQAB2 = SQRT(AB2)
  190 YINT = YINT + AB1/SQAB2
      YINT = YINT*PAI/NCHBY
 1000 CONTINUE
      RETURN
      END
vv
```

```
      SUBROUTINE CAVITY (XCC,YCC)
C THIS SUBROUTINE IS CALLED FROM DXFNEW FOR F(5).
      DIMENSION CKEX(100),SKEY(100),ANSI1(100),SRI2(100),SIC3I3(100)
      DIMENSION SIC4I4(100),XST(6)
      DIMENSION CAVXX(100),CAVYY(100)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AU(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFAI,GAMMA
      COMMON       SBETA,XXM,ICPI,SARCOO(513)
      COMMON IOUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,LSS
      COMMON XSN(6),     CLE,ERC,YYY,XM,ITERA,SXSIC(6),SXSICC(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XCX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
C XCCC IS THE CAVITY END POINT CALCULATED IN SUB. CAVITY.
      CDEL = COS(DELTA)
      SDEL = SIN(DELTA)
      PAI = 3.141592654
      DO 1 LOA = 1,6
    1 XST(LOA) = YXS(LOA)
      SCGM = SQRT(1.+XST(6))
      CCC1=ALOG(1.+XST(6))/(2.*PAI)
      NCAV=80
      NCAV1=NCAV+1
      CAVS = (XST(2)-XST(1))/NCAV
C     LEAVE THE LAST POINT OF XSI = 0 SINCE THERE IS A
C        SINGULARITY FOR SINGLE SPIRAL VORTEX MODEL.
      DO 2 KLM = 1,NCAV1
      XCA = XST(1) +CAVS* (KLM-1)
C     REAL PART OF OMEGA = BETA* PAI.
      IF (KLM.EQ.1) GO TO 3
      IF(KLM.EQ.NCAV1) GO TO 10
C-----IC1(XSI) CALCULATION, CALLING OFSIM1.
    3 IF (IJ.GE.34) GO TO 75
      NOF = 3
      CALL OFSIM1(ANS,NOF,XCA)
C     ANS IS A SOLUTION FOR IC1(XCI), XCI IS IDENTICAL TO XCA.
      IF (IJ.EQ.27) ANSI1(KLM) = ANS
      GO TO 76
   75 ANS = ANSI1(KLM)
   76 CONTINUE
C---- IC2(XSI) CALCULATION.
      IF(IJ.GE.34) GO TO 77
      ISIC = 1
      CALL IC2(SR,SM,XCA,ISIC)
C     ONLY SR IS UTILIZED-- SM IS FOR RMINT.
      IF (IJ.EQ.27) SRI2(KLM) = SR
      GO TO 78
   77 SR = SRI2(KLM)
   78 CONTINUE
C-----IC3 (XSI) CALCULATION-- USE CHEBYSHEV-GAUSS
C     QUADRATURE FORMULA.
      IF (IJ.GE.34) GO TO 80
      BPC5 = (XST(1)+XST(2))*.5
      CMB5 = (XST(2)-XST(1))*.5
      A31 = (BPC5+1.)/CMB5
```

```
      A32 = (-BPC5+XST(3))/CMB5
      EK1 = XCA-XST(2)
      EK2 = (XCA+1.)*(XCA-XST(1))*(XCA-XST(3))
      EK3 = SQRT(EK1/EK2)
      EF3B = CMB5*EK3
      SIC3 = 0.
      DO 5 ISUM = 1,NCHBY
      EJ1=(AJ(ISUM)+A31)*(A32-AJ(ISUM))
      SEJ1 = SQRT(EJ1)
      EF3 = (1.-AJ(ISUM))/SEJ1
      EF3A = CMB5*AJ(ISUM)+BPC5-XCA
    5 SIC3 = SIC3+(EF3-EF3B*SQRT(1.-AJ(ISUM)**2))/EF3A
      SIC3 = SIC3*PAI/NCHBY
      SIC3 = SIC3+ALOG((XST(2)-XCA)/(XCA-XST(1)))*EK3
      IF(IJ.EQ.27) SIC3I3(KLM) = SIC3
      GO TO 81
   80 SIC3 = SIC3I3(KLM)
   81 CONTINUE
C-----IC4(XSI)----.
C     USE CHEBYSHEV-GAUSS QUADRATURE FORMULA
C        IN THE SAME MANNER AS THAT FOR I4 IN
C        OFSIM3.
      IF(IJ.GE.34) GO TO 82
      FPC5 = (XST(3)+XST(2))*.5
      FMC5 = (XST(3)-XST(2))*.5
      A41 = (FPC5+1.)/FMC5
      A42 = (FPC5-XST(1))/FMC5
      SIC4 = 0.
      DO 7 ISUM= 1,NCHBY
      RA = (BBTAN2(ISUM)+PAI)*(1.+AJ(ISUM))
      RB = (AJ(ISUM)+A41)*(AJ(ISUM)+A42)
      SRB = SQRT(RB)
      RC = RA/SRB
      RD = FMC5*AJ(ISUM)+FPC5-XCA
    7 SIC4 = SIC4+RC/RD
      SIC4 = SIC4*PAI/NCHBY
      IF(IJ.EQ.27) SIC4I4(KLM)= SIC4
      GO TO 83
   82 SIC4 = SIC4I4(KLM)
   83 CONTINUE
      IF (IJ.EQ.27.AND.KLM.EQ.2) WRITE(6,85) ANS,SR,SIC3,SIC4,KLM
      IF (IJ.EQ.27.AND.KLM.EQ.40) WRITE(6,85) ANS,SR,SIC3,SIC4,KLM
      IF (IJ.EQ.27.AND.KLM.EQ.80) WRITE(6,85) ANS,SR,SIC3,SIC4,KLM
   85 FORMAT (10X,'----I1,I2,I3,I4 OF CAVITY ARE----',4(E14.7,2X),2X,
     A'KLM=',I4)
C  HC(XSI) = 1/EK3  ALREADY CALCULATED.
      UU2 = COS(ALFA1+GAMMA)/COS(XST(5)+GAMMA)
      GC = (-ANS/PAI-SR*(CCC1-ALOG(UU2)/PAI)*SIC3
     1-SIC4/PAI)/EK3
      GO TO 25
    3 GC = BETAB+PAI
      GO TO 25
   10 GC=BETAC+PAI
C BETAB AND BETAC( BODY ANGLES AT B AND C) MUST BE SPEICIEED IN COMMON.
   25 CONTINUE
      XXS = XCA*CDEL
      YYT = XCA-XST(4)*SDEL
      YYT2 = YYT**2
      XXU = XST(4)*CDEL
      XXU2 = XXU**2
```

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      XYB = YYT2+XXU2
      DWDX = DGAP*XXS/(XYB*PAI)
      CGC = COS(GC)
      SGC = SIN(GC)
      CFC = DWDX/SCGM
      CKEX(KLM) = CGC*CFC
      SKEY (KLM) = SGC*CFC
    2 CONTINUE
      CAVXX(1)=0.
      CAVYY(1)=0.
      DO 15 ICAV=3,NCAV1,2
      CAVXX(ICAV) = CAVXX(ICAV-2)+CAVS*(CKEX(ICAV-2)+4.*
     1CKEX(ICAV-1)+CKEX(ICAV))/3.
   15 CAVYY(ICAV) = CAVYY(ICAV-2)
     1+CAVS*(SKEY(ICAV-2)+4.*SKEY(ICAV-1)+SKEY(ICAV))/3.
      IF(IJ.EQ.27) GO TO 100
      GO TO 101
  100 DO 102 ICAV=1,NCAV1,2
      CAVX(ICAV)=CAVXX(ICAV)
  102 CAVY(ICAV)=CAVYY(ICAV)
      XCCC=CAVX(NCAV1)
      YCCC=CAVY(NCAV1)
  101 CONTINUE
      XCC=CAVXX(NCAV1)
      YCC=CAVYY(NCAV1)
      RETURN
      END
vv
```

```
      SUBROUTINE G2 (XS2,AG2,IS2)
      DIMENSION    XST(6),XI21S(200),XI22S(200),XI23S(200),XI24S(200)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHAR2,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON        SBETA,XXM,ICPI,SARCOD(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),     CLE,ERC,YYY,XM,ITERA,SXSIO(6),SXSICO(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,A8,B8,C8,D8,TGAUS(100),WGAUS(100),NGAUS
C     THIS SUBROUTINE IS CALLED BY OFSIM5.
C     THIS SUBROUTINE CALCULATES FUNCTION G2(XS2) WHICH
C     INCLUDES I21(XS2) TO I24(XS2).
C     XS2 IS XSI- AG2 IS THE SOLUTION OF INTEGRALS.
      DO 1 IGP=1,6
    1 XST(IGP)=YXS(IGP)
      PAI = 3.141592654
      CCC1=ALOG(1.+XST(6))/(2.*PAI)
      IF (IJ.GE.47) GO TO 100
C---I21(XSI)----.
C     THE SAME INTEGRATION AS THAT IN
C     SUBROUTINE CAVITY FOR GC(XSI)
      NDF = 3
      CALL OFSIM1(ANS,NDF,XS2)
      XI21 = ANS
      IF(IJ.EQ.40) XI21S(IS2) = XI21
C----I22(XSI)----.
C     USE THE SAME SUBROUTINE IC2 AS
C     USED IN CAVITY WITH ISIC=1.
      ISIC=1
      CALL IC2(SR,SM,XS2,ISIC)
      XI22 = SR
C     NOTE THAT SM IS DUMMY VARIABLE.
      IF(IJ.EQ.40) XI22S(IS2) = XI22
C----I23(XSI)----.
C     USE CHEBYCHEV-GAUSS QUADRATURE FORMULA
C       IN EXACTLY SIMILAR MANNER TO THAT IN
C         OFSIM3 FOR I3.
      XI23 = 0.
      BPC5 = (XST(1)+XST(2))*.5
      CM85 = (XST(2)-XST(1))*.5
      A31 = (BPC5 + 1.)/CM85
      A32 = (-BPC5 + XST(3))/CM85
      DO 2 ISUM = 1,NCHBY
      HA1 = 1.-AJ(ISUM)
      HA2 = (AJ(ISUM) + A31)*(A32-AJ(ISUM))
      SHA2 = SQRT(HA2)
      F3I3 = HA1/SHA2
      F3AI3 = CM85*AJ(ISUM)+BPC5-XS2
    2 XI23 = XI23+F3I3/F3AI3
      XI23 = XI23*PAI/NCHBY
      IF (IJ.EQ.40) XI23S(IS2) = XI23
C-----I24-----.
C     USE CHEBYCHEV-GAUSS QUADRATURE
C        FORMULA BY ASSUMING THAT
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C         THE KERNEL FCN. IS SMOOTH.
      HU = (XS2+1.)*(XS2-XST(1))*(XST(3)-XS2)
      HV = XS2-XST(2)
      HW = SQRT(HU/HV)
      FPC5 = (XST(3)+XST(2))*.5
      FMC5 = (XST(3)-XST(2))*.5
      A41 = (FPC5+1.)/FMC5
      A42 = (FPC5-XST(1))/FMC5
      XI24 = 0.
      DO 10 ISUM = 1, NCHBY
      TPA1 = AJ(ISUM)+A41
      TPA2 = AJ(ISUM)+A42
      STP = SQRT(TPA1*TPA2)
      F4T = (BETAN2(ISUM)+PAI)*(1.+AJ(ISUM))/STP
C     BETAN2 IS CHEBY-GAUSS VERSION FOR BETA ON THE SECOND ARC.
      F4A = FMC5*AJ(ISUM)+FPC5-XS2
      ST2 = SQRT(1.-AJ(ISUM)**2)
      F4B = FMC5 *ST2*(BETAN2(IS2 )+PAI)/HW
   10 XI24 = XI24+(F4T-F4B)/F4A
      XI241 = XI24*PAI/NCHBY
C     BETAN2 IS USED FOR SIMPSONTS RULE.
      XLG = ALOG((XST(3)-XS2)/(XS2-XST(2)))
C     IS2 IS TRANSFERED THROUGH 32-ARGUMENT.
      XI242 = XLG*(BETAN2(IS2)+PAI)/HW
      XI24 = XI241+XI242
      IF(IJ.EQ.40) XI24S(IS2) = XI24
      GO TO 101
  100 XI21 = XI21S(IS2)
      XI22 = XI22S(IS2)
      XI23 = XI23S(IS2)
      XI24 = XI24S(IS2)
  101 XS24 = -XI21/PAI-XI22
C              IAP/)ECAPSE/)AMMAG+)S(TS)X(SOC/)AMMAG+1AFLA(SOC(GOLA-1CCC=B2SX
      XS25 = CCC1-ALOG(COS(ALFA1+GAMMA)/COS(XST(5)+GAMMA))/PAI                    C
      XS2C = XS2B*XI23
      XS2D = -XI24/PAI
      AG2 = (XS24+XS2C+XS2D)*HW
      IF (IJ.EQ.27.AND.IS2.EQ.2) WRITE(6,52) XI21,XI22,XI23,XI24,IS2
      IF (IJ.EQ.27.AND.IS2.EQ.10) WRITE(6,52) XI21,XI22,XI23,XI24,IS2
      IF (IJ.EQ.27.AND.IS2.EQ.30) WRITE(6,52) XI21,XI22,XI23,XI24,IS2
   52 FORMAT(10X,'---I1,I2,I3,I4 OF F(5) ARE----',4(E14.7,2X),2X,
     A 'IS2=',I4)
      RETURN
      END
vv
```

```
      SUBROUTINE RMINT (SR,SM,MIG)
      DIMENSION XST(6)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BETAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DSAP,ALFAI,GAMMA
      COMMON        SBETA,XXM,ICPI,SARCCD(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),     CLE,ERC,YYY,XM,ITERA,SXSIG(6),SXSIOO(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),YCX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AA,BB,CC,DD,TGAUS(100),,GAUS(100),NGAUS
      PAI = 3.141592654
      IF (ICPI.EQ.0) GO TO 10
      DO 12 IS = 1,6
   12 XST(IS) = XSN(IS)
      GO TO 11
   10 DO 1 IS = 1,6
    1 XST(IS) = YXS(IS)
   11 CONTINUE
      XX1 = XST(4)*SIN(DELTA)
      YY1 = XST(4)*COS(DELTA)
      YY12 = YY1**2
      CB5 = (XST(2)-XST(1))*.5
      BC5 = (XST(1)+XST(2))*.5
      A31 = (BC5+1.)/CB5
      A32 = (-BC5+XST(3))/CB5
      BM15 = (XST(1)-1.)*.5
      BP15 = (XST(1)+1.)*.5
      A11 = (BM15-XST(2))/BP15
      A12 = (BM15-XST(3))/BP15
      FPC5 = (XST(3)+XST(2))*.5
      FMC5 = (XST(3)-XST(2))*.5
      A41 = (FPC5+1.)/FMC5
      A42 = (FPC5-XST(1))/FMC5
      IF(MIG.EQ.4) GO TO 4
      IF (MIG.EQ.3) GO TO 3
      IF (MIG.EQ.2) GO TO 2
C     AJ(I) ARE ALREADY CALCULATED IN SUBROUTINE
C          TFINTL1 AND STORED IN COMMON AREA.
      SR=0.
      SM=0.
      DO 20 ISUM = 1,NCHBY
      GX1 = 1.-AJ(ISUM)
      GY1 = (AJ(ISUM)+A31)*(A32-AJ(ISUM))
      SGY1 = SQRT(GY1)
      FF3 = GX1/SGY1
      FX1 = CB5*AJ(ISUM)+BC5
      FX2 = FX1-XX1
      FX22=FX2**2
      FX3 = FX22+YY12
      FF31 = FX2/FX3
      FF32 = YY1/FX3
      SR = SR+FF3*FF31
   20 SM = SM+FF3*FF32
      SR = SR*PAI/NCHBY
      SM = SM*PAI/NCHBY
```

```
      GO TO 1000
    2 CONTINUE
      IF (ISHARP.EQ.1) GO TO 100
C     ISHARP = 1 MEANS THAT THE FOIL HAS ROUNDED L.E.
C     SO THAT THE SIMPSONTS RULE IS USED.
C     ISHARP = 0 MEANS THAT THE FOIL HAS SHARP L.E.
C     SO THAT CHEBYSHEV GAUSS FORMULA CAN BE USED AS BELOW.
      SR = 0
      SM = 0
      DO 30 ISUM = 1,NCHBY
      ST11 = AJ(ISUM)+A11
      ST12 = AJ(ISUM)+A12
      FK1 = BBTAN(ISUM)*SQRT(ST11/ST12)
      UN1 = BP15*AJ(ISUM)+BM15-XX1
      UN12 = UN1**2
      UN13 = UN12+YY12
      FK11 = UN1/UN13
      FK12 = YY1/UN13
      SR = SR+FK1*FK11
   30 SM = SM+FK1*FK12
      SR = SR*PAI/NCHBY
      SM = SM*PAI/NCHBY
      GO TO 1000
  100 CONTINUE
C     THIS IS THE CASE THAT THE FOIL HAS ROUNDED L.E.
      NOF = 1
      XCA = 0.
      CALL DFSIM1(SR,NOF,XCA)
C  XCA IS DUMMY----ONLY USED FOR F(5) IN DXFNEW.
      NOF=2
      CALL DFSIM1(SM,NOF,XCA)
      GO TO 1000
    3 CONTINUE
C     USE CHEBYSHEV-GAUSS FORMULA SINCE BETA
C     IN THIS REGION IS SMOOTH.
C     BBTAN2 (ISUM) ARE ALREADY CALCULATED AT TFINT_T.
      SR = 0.
      SM = 0.
      DO 50 ISUM = 1,NCHBY
      PSL = (BBTAN2(ISUM)+PAI)*(1.+AJ(ISJM))
      PSM = (AJ(ISUM)+A41)*(AJ(ISJM)+A42)
      SQPSM = SQRT(PSM)
      FF4 = PSL/SQPSM
      PSN = FMC5*AJ(ISUM)+FPC5-XX1
      PSN2 = PSN**2
      FF41 = PSN/(PSN2+YY12)
      FF42 = YY1/(PSN2+YY12)
      SR = SR+FF4*FF41
      SM =SM+FF4*FF42
   50 CONTINUE
      SR = SR*PAI/NCHBY
      SM = SM*PAI/NCHBY
      GO TO 1000
    4 CONTINUE
C     XCA IS DUMMY, ONLY USED FOR IC2 IN F(5)
      XCA = 0.
      ISIC = 0
C     SUBROUTINE IC2 IS ALSO USED IN F(5).
      CALL IC2(SR,SM,XCA,ISIC)
 1000 RETURN
```

```
      SUBROUTINE ARCS2(S2,XC,YC)
      COMMON/THICK/TH
C THIS IS CALLED FROM F(5) AFTER CAVITY SUBROUTINE.
C FOR S2, THE TOTAL ARC LENGTH S2 IS CALCULATED BY THIS SUBROUTINE, BUT
C     FOR BETAN2 FINDING, ARCLEN AND BBBETA ARE USED AS FOR S1.
      PAI=3.141592654
      XZ=.5
      IF (TH.LE.1.E-6) GO TO 1
      YZ = (TH**2-.25)/(2.*TH)
      HGZ=ATAN(-XZ/YZ)
      XCMZ=XC-XZ
      YCMZ=YC-YZ
      AL=ATAN(XCMZ/YCMZ)
      BT=HGZ-AL
      PBT=BT/(2.*PAI)
      XCMZ2=XCMZ**2
      YCMZ2=YCMZ**2
      S2=2.*PAI*SQRT(XCMZ2+YCMZ2)*PBT
      GO TO 2
    1 S2 = 1.-XC
    2 CONTINUE
      RETURN
      END
vv
```

```
      SUBROUTINE ARCLEN(XSS,XL,XH,ISII2)
      COMMON/THICK/TH
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BETAN(100),BETAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALPHA1,GAMMA
      COMMON        SBETA,XXM,ICPI,SARCOO(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),      CLE,ERC,YYY,XM,ITEPA,SXSIC(6),SXSICC(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCC(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XCX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
C FOR PLANO-CONVEX CASCADE OF WADE AND ACOSTA.
      IF(ISII2.EQ.1) GO TO 10
      XSS=XH-XL
      GO TO 11
   10 AT1=2.*XH-1.
      AT2=2.*XL-1.
      PX2=XCCC**2
      PY2=YCCC**2
      IF (TH.LE.1.E-6) GO TO 3
      CTH = (TH**2-.25)/TH
      CEND=PX2+PY2-XCCC+CTH*YCCC
      CONS=SQRT(CTH**2+4.*CEND+1.)
      AAT1=ASIN(AT1/CONS)
      AAT2=ASIN(AT2/CONS)
      XSS=.5*(AAT1-AAT2)*CONS
      GO TO 11
    3 XSS = XH-XL
   11 CONTINUE
      RETURN
      END
VV
```

```
      SUBROUTINE XCYC(XCB,YCB,CX,CY)
C THIS IS CALLED FOR FLAND-CONVEX CASCADE.
      COMMON/THICK/TH
      XZ=.5
      IF (TH.LE.1.E-6) GO TO 3
      YZ = (TH**2-.25)/(2.*TH)
      UK=CY-YZ
      DK=CX-XZ
      IF(DK.EQ.0.) GO TO 1
      AK=UK/DK
      AK2=AK**2
      XZ2=XZ**2
      YZ2=YZ**2
      R2=XZ2+YZ2
      SR=SQRT(R2/(1.+AK2))
      XCB=XZ+SR
      IF(DK.LT.0.) XCB=XZ-SR
      YCB=AK*(XCB-XZ)+YZ
      GO TO 2
    1 CONTINUE
      XCB=XZ
      YCB=TH
      GO TO 2
    3 XCB = CX
      YCB = 0
    2 CONTINUE
      RETURN
      END
vv
```

```
      SUBROUTINE SHAPE(X,Y,BETA,IS1I2)
      COMMON /THICK/TH
      COMMON YCCC,SBETA2
      COMMON XITN(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALPHA1,GAMMA
      COMMON       SBETA,XKM,ICPI,SARCOD(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YR,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),     CLE,ERC,YYY,XM,ITERA,SXSIC(6),SXSIOO(6),YXS(6)
      COMMON PSIZ,LP,SARC(513),SARCD(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XDX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
C PLANO-CONVEX CASCADE CASE.
      PAI=3.141592653
      IF(IS1I2.EQ.1) GO TO 1
      BETA=0.
      Y=0.
      GO TO 2
    1 CONTINUE
      IF (TH.LE.1.E-6) GO TO 3
      PX2=XCCC**2
      PY2=YCCC**2
      CTH = -(TH**2-.25)/TH
      CEND=PX2+PY2-XCCC+CTH*YCCC
      YCC=CTH
      YCC2=YCC**2
      YSC=YCC2-4.*(X**2-X-CEND)
      SYS=SQRT(YSC)
      Y=(-YCC+SYS)*.5
      YDX=-(2.*X-1.)/(2.*Y+YCC)
      BETA=ATAN(YDX)-PAI
      GO TO 2
    3 CONTINUE
      Y = 0.
      BETA=-PAI
    2 CONTINUE
      RETURN
      END
vv
```

```
      SUBROUTINE MOSEC(A,B,ER1,ER2,X,J,XLPA,IS1I2)
      J=0
      X1=A
      X2=B
    4 J=J+1
      IF(J.GE.600) GO TO 8
      CALL FARC(PFX1,XLPA,X1,IS1I2)
      CALL FARC(PFX2,XLPA,X2,IS1I2)
      X3=X1+(X2-X1)*PFX1/(PFX1-PFX2)
      CALL FARC(PFX3,XLPA,X3,IS1I2)
      IF(PFX3)1,2,3
    1 X2=X3
      X1=X1
      IF(A-B)10,10,11
   10 Y=X3-ER1
      IF(Y.LE.0.) Y=0.
      GO TO 12
   11 Y=X3+ER1
   12 CALL FARC(PFY,XLPA,Y,IS1I2)
      IF(PFY) 5,2,2
    3 X1=X3
      X2=X2
      IF(A-B) 20,20,21
   20 Z=X3+ER1
      GO TO 22
   21 Z=X3-ER1
   22 CALL FARC(PFZ,XLPA,Z,IS1I2)
      IF(PFZ)2,2,5
    5 GO TO 4
    2 PP= ABS(PFX3)
      IF(PP-ER2) 6,6,4
    6 X=X3
      GO TO 7
    8 WRITE(6,9) J
    9 FORMAT(1X,2HJ=,I3)
      STOP
    7 RETURN
      END
vv
```

```
      FUNCTION AITKEN(XX,YY,X,N)
      DIMENSION XX(1),YY(1),ZZ(21)
      IF (N)1,1,2
    1 AITKEN=YY(1)
      RETURN
    2 IF (N.GT.20) N=20
      M=N+1
      DO 3 K=1,M
    3 ZZ(K)=YY(K)
      DO 4 I=1,N
      DO 4 J=I,N
    4 ZZ(J+1)=ZZ(I)+(X-XX(I))*(ZZ(J+1)-ZZ(I))/(XX(J+1)-XX(I))
      AITKEN=ZZ(N+1)
      RETURN
      END

       SUBROUTINE DETERM (A,N,D)
C     DETERM  REVISED 02-28-73
      REAL M
      DIMENSION A(50,50),SAVEA(50,50)
      IF (N .EQ. 1)GO TO 46
      C = 1.
      NN = N
      DO 9 J = 1,NN
      DO 9 I = 1,NN
    9 SAVEA(I,J) = A(I,J)
      K = 1
      GO TO 13
   12 K = K + 1
   13 I = K + 1
      L = K
      GO TO 17
   16 I = I + 1
   17 IF (ABS(SAVEA(I,K)) .GT. ABS(SAVEA(L,K))) L = I
      IF (I .NE. NN)GO TO 16
      IF (L .EQ. K)GO TO 28
      J = K
C     ROW INTERCHANGE
      GO TO 23
   22 J = J + 1
   23 SAVEKJ = SAVEA(K,J)
      SAVEA(K,J) = SAVEA(L,J)
      SAVEA(L,J) = SAVEKJ
      IF (J .NE. NN)GO TO 22
      C = -C
   28 I = K + 1
      GO TO 31
   30 I = I + 1
   31 CONTINUE
      IF (SAVEA(K,K) .EQ. 0.) GO TO 48                                  02-28-73
      M = SAVEA(I,K) / SAVEA(K,K)
      SAVEA(I,K) = 0.
      J = K + 1
      GO TO 36
   35 J = J + 1
   36 SAVEA(I,J) = SAVEA(I,J) - M * SAVEA(K,J)
      IF (J .NE. NN)GO TO 35
      IF (I .NE. NN)GO TO 30
      IF (K .NE. (NN-1))GO TO 12
```

```
      D = 1.
      DO 43 I = 1,NN
      J = I
      D = D * SAVEA(I,J)
      IF (ABS(D) .LT. 1.E-36) GO TO 48
   43 CONTINUE
      D = D * C
      RETURN
   46 D = A(1,1)
      RETURN
   48 D = 0.
      WRITE (6,51)
      RETURN
   51 FORMAT(//5X,'ERROR MESSAGE FROM DETERM.'//
     1 5X,'MATRIX IS SINGULAR. DETERMINANT SET = 0.' //)
      END
$$
```

```
C THIS GIVES BETA(X(XSI)).
      SUBROUTINE BBBETA(XX,RBETA,IS1I2)
      COMMON YCCC,SBETA2
      COMMON XITM(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,XCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALFA1,GAMMA
      COMMON        SBETA,KKM,ICPI,SARCCD(513)
      COMMON IDUL,XA,XB,XC,TANG,EP,YC,YP,JBIGS,ALBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),     CLE,ERC,YYY,XM,ITERA,SXSIC(6),SYSICC(6),YYS(6)
      COMMON PSIZ,LP,SARC(513),SARCC(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XCX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AS,BB,CE,DB,TGAUS(100),WGAUS(100),NGAUS
      ER1=5.E-3
      ER2=5.E-3
      IF(IS1I2.EQ.1) GO TO 20
C IS1I2=0 FOR S1.
C       1 FOR S2.
      LPMAA=LPM-1
      SMALS=SARC(LP)
      IF(LP.EQ.LPM) GO TO 10
      DSS=SARC(LP)-SARC(LP+1)
      XLPA=XX
      GO TO 21
   20 SMALS=SARC2(LP)
      IF(LP.EQ.1)GO TO 110
      XLPA=XX
      DSS=SARC2(LP)-SARC2(LP-1)
   21 CONTINUE
      X1A=XLPA
    4 X1B=X1A+.001
      CALL FARC(FAR,XLPA,X1B,IS1I2)
      IF(FAR.LT.0.) GO TO 3
      X1A=X1B
      GO TO 4
    3 CALL MOSEC(X1A,X1B,ER1,ER2,XX,JJI,XLPA,IS1I2)
      GO TO 11
   10 XX=0.
      GO TO 11
  110 XX=XCCC
   11 CALL SHAPE(XX,Y,RBETA,IS1I2)
      RETURN
      END
vv
```

```
      SUBROUTINE FARC(FAR,XLPA,X1B,IS1I2)
      COMMON YCCC,SBETA2
      COMMON XITN(200),XITN(200),ANSG2S(200),SARC2(200)
      COMMON CAVX(100),CAVY(100),BETAB,BETAC,YCCC,NCAV,LPMM,NS2
      COMMON AJ(100),ISHARP,NCHBY,BBTAN(100),BBTAN2(100),BETAN2(100)
      COMMON FLAPAN,DELTA,DGAP,ALPA1,GAMMA
      COMMON        SBETA,XXM,ICPI,SARCOO(513)
      COMMON IDJL,XA,XB,XC,TANG,EP,YC,YP,JBIGS,XLBIGS,BIGS,SMALS,DSS
      COMMON XSN(6),      CLE,ERC,YYY,XM,ITERA,SXSIO(6),SXSIOO(6),YYS(6)
      COMMON PSIZ,LP,SARC(513),SARCO(513),LPM,DE
      COMMON BETAN(513),BETAM(513),IJ,LPK,XII(200),XJJ(200),XCX
      COMMON XROUND,A2AA,B2BB,C2CC
      COMMON AAAA,BBBB,CCCC,AB,BB,CB,DB,TGAUS(100),WGAUS(100),NGAUS
      IF(XLPA.EQ.X1B) GO TO 1
      CALL ARCLEN(XSS,XLPA,X1B,IS1I2)
      GO TO 2
    1 XSS=0.
    2 CONTINUE
      FAR=DSS-XSS
      RETURN
      END
```

vv

7.0 REFERENCES

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